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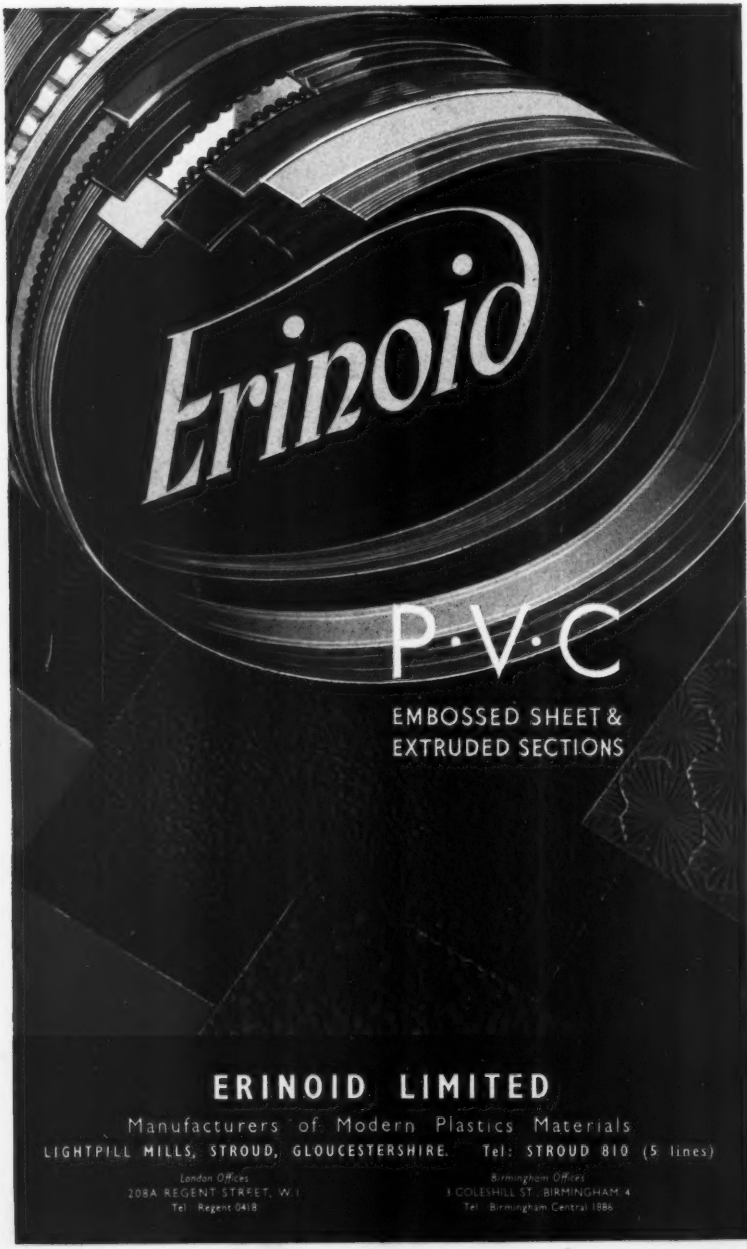
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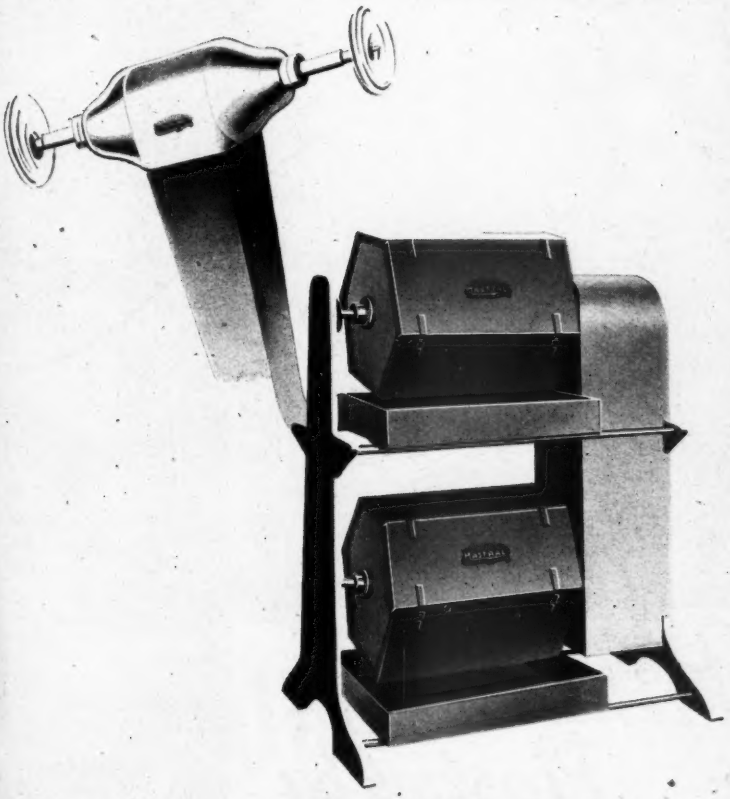

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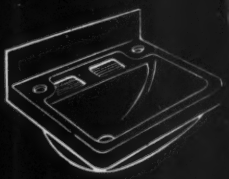

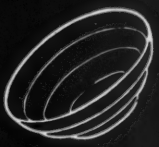

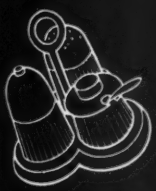

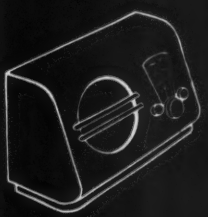

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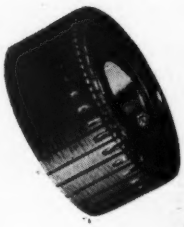

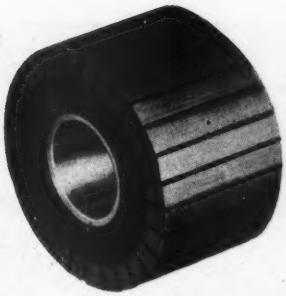

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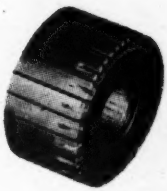

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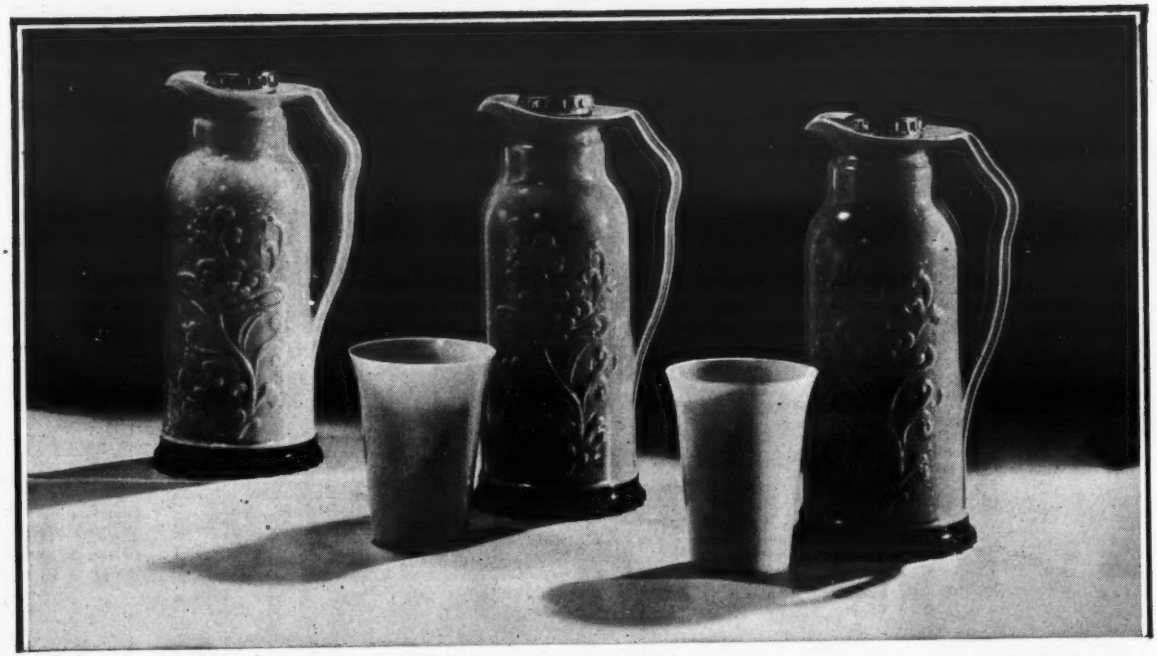

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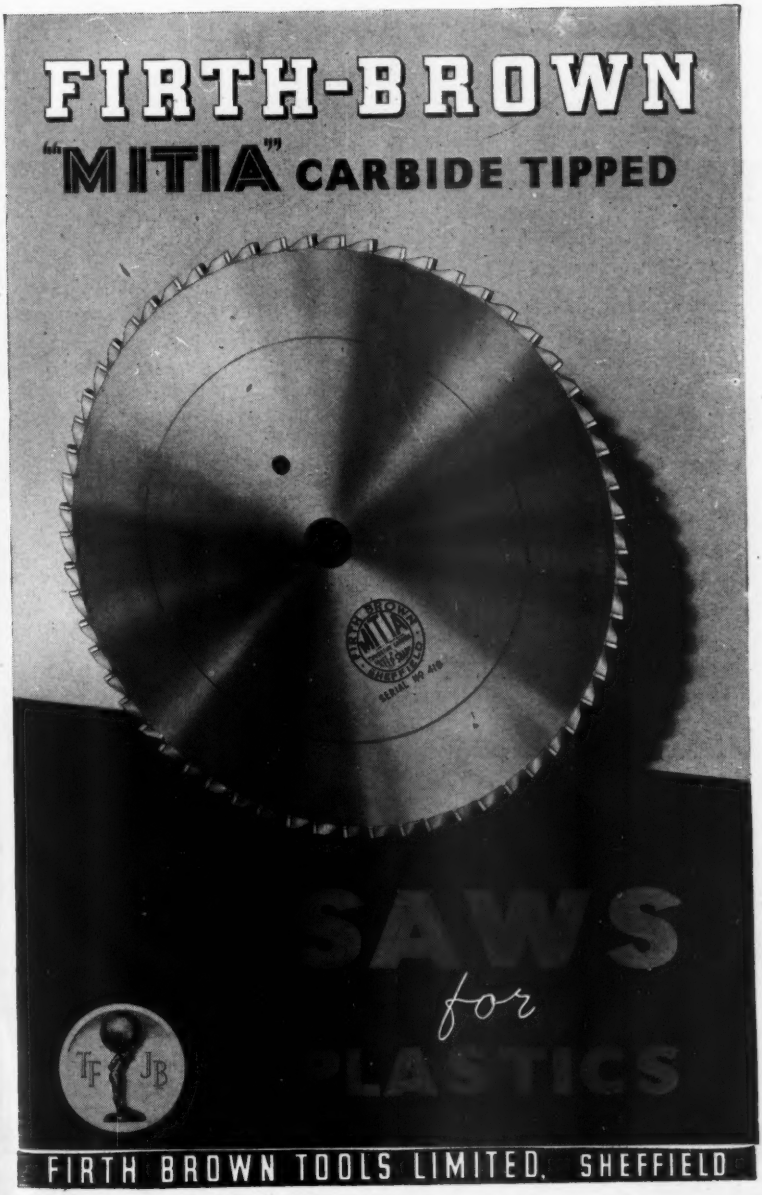
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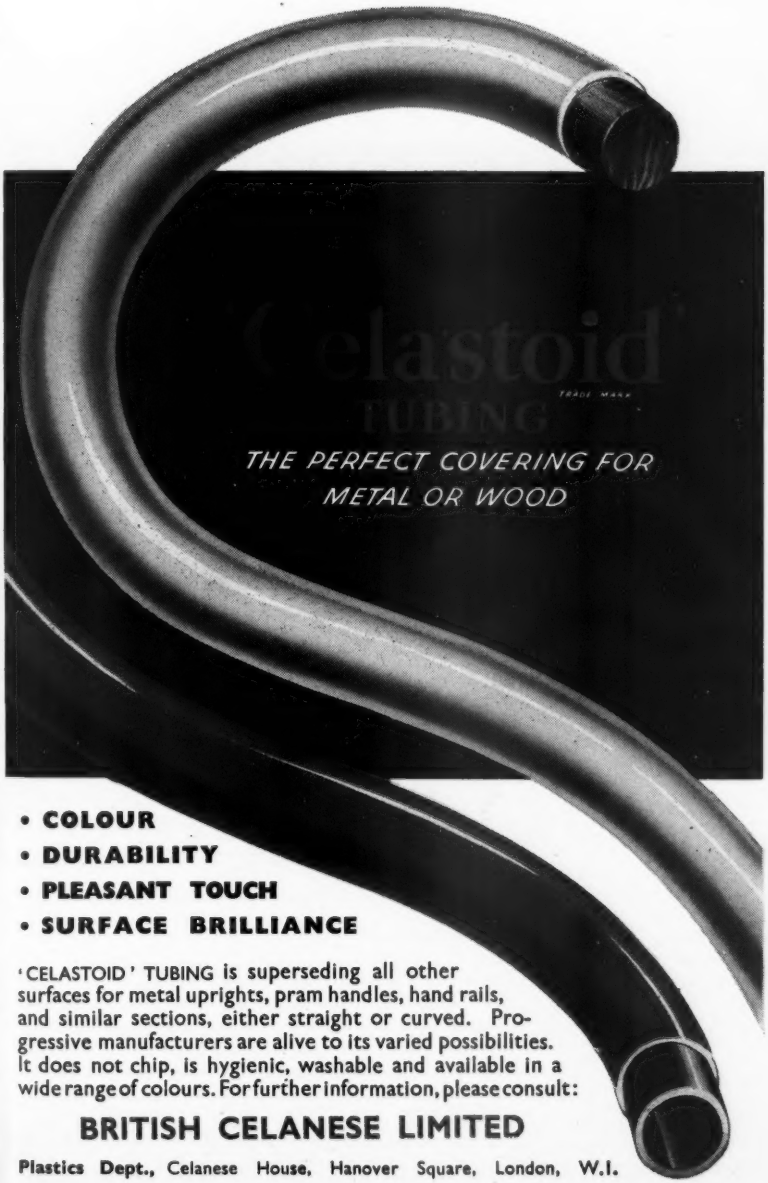

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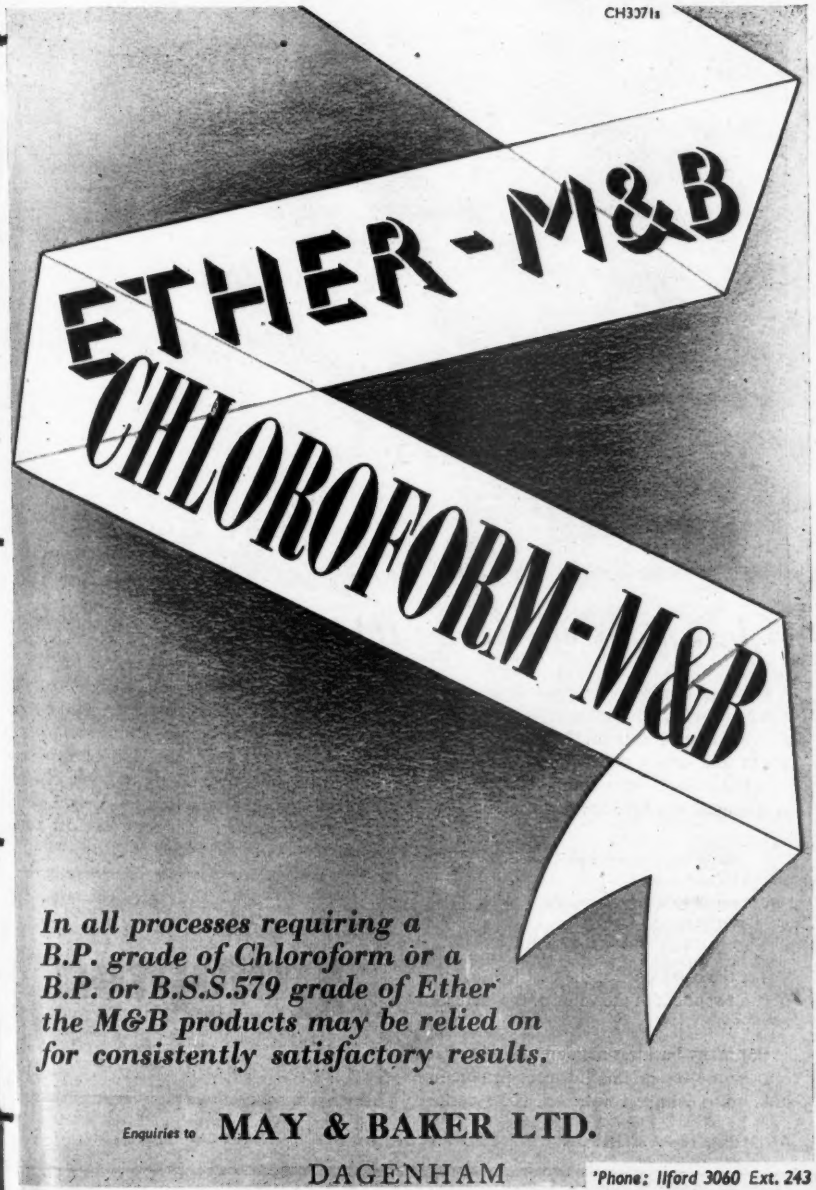
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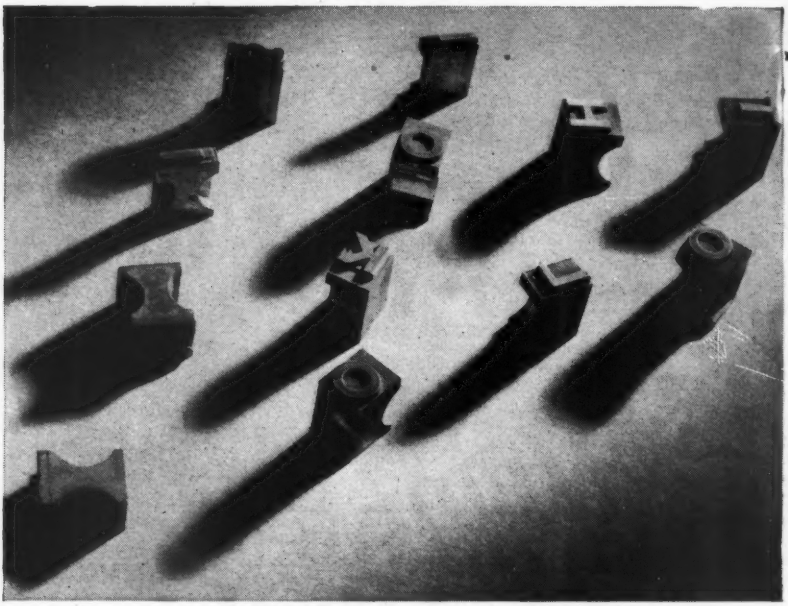

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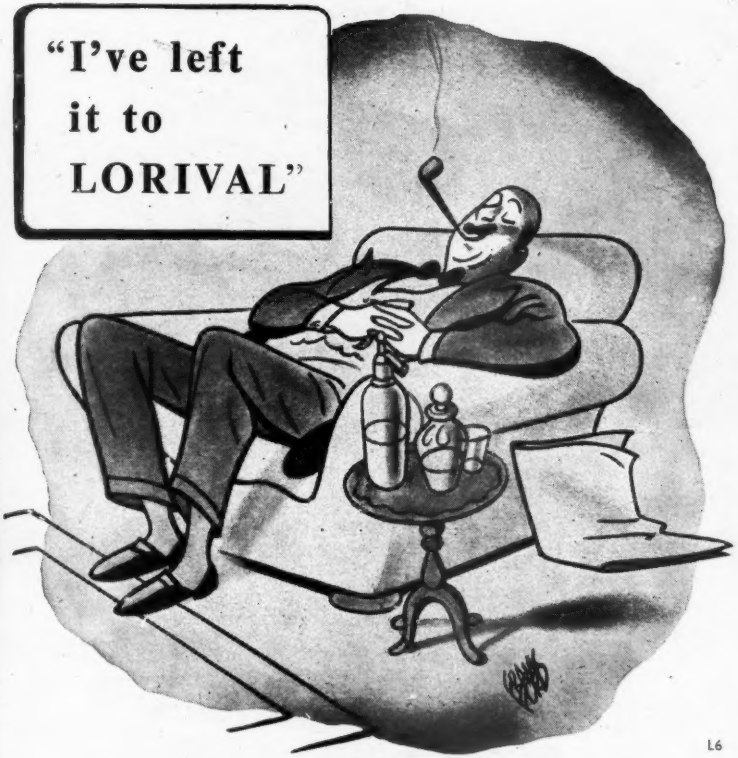

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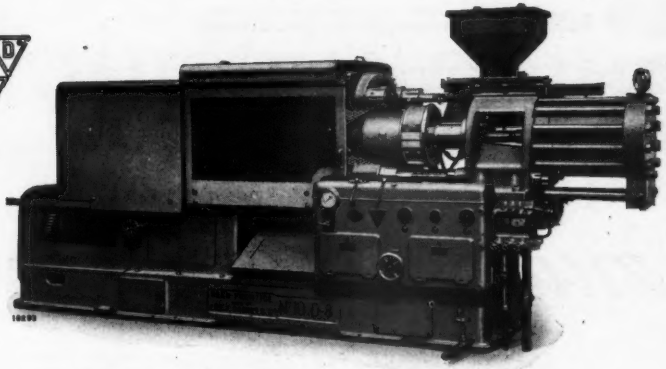

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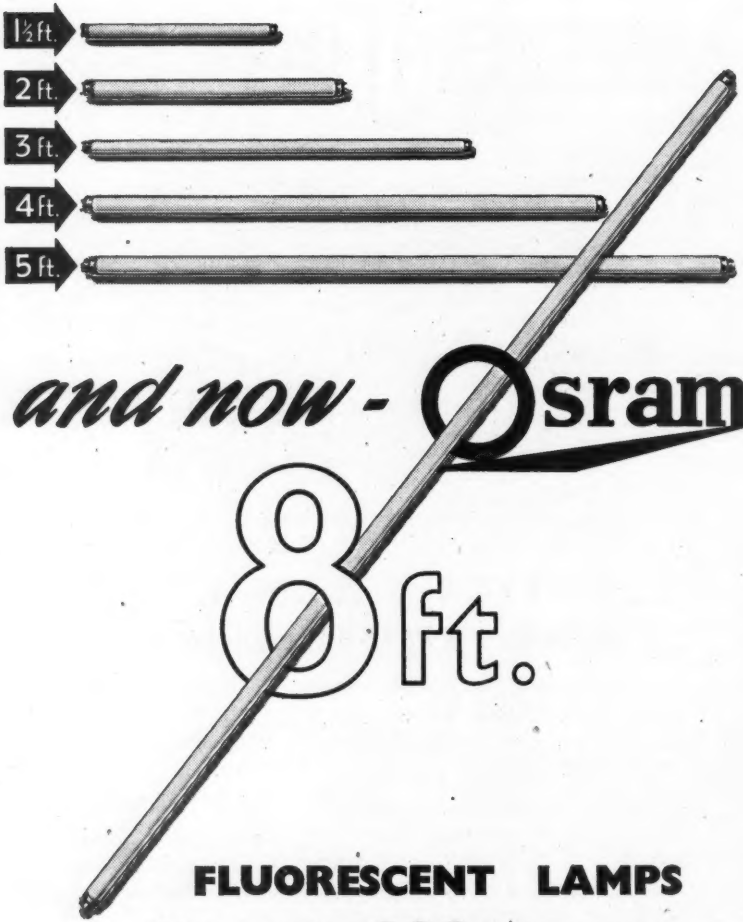

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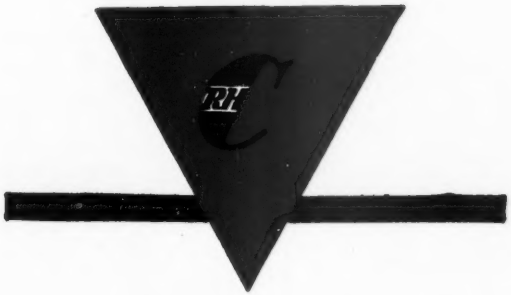

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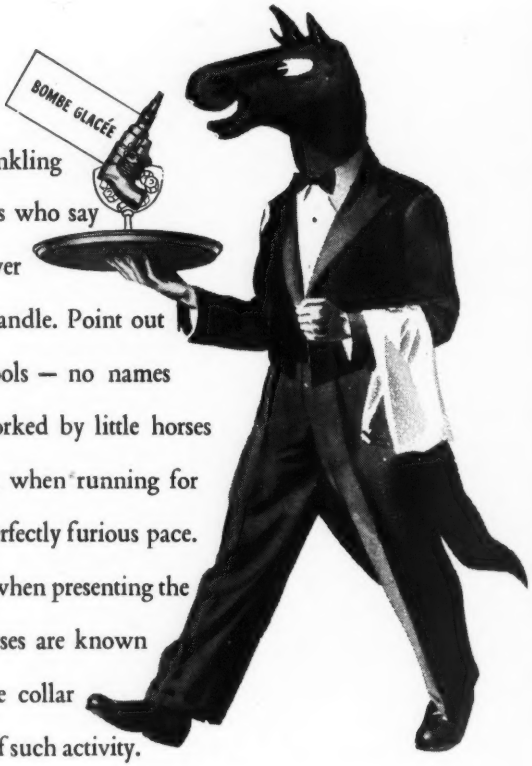

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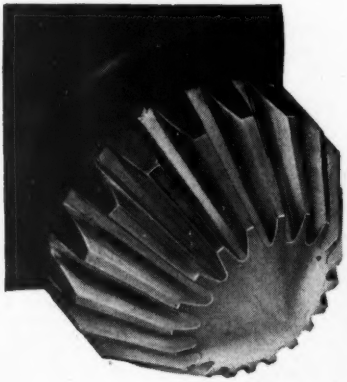

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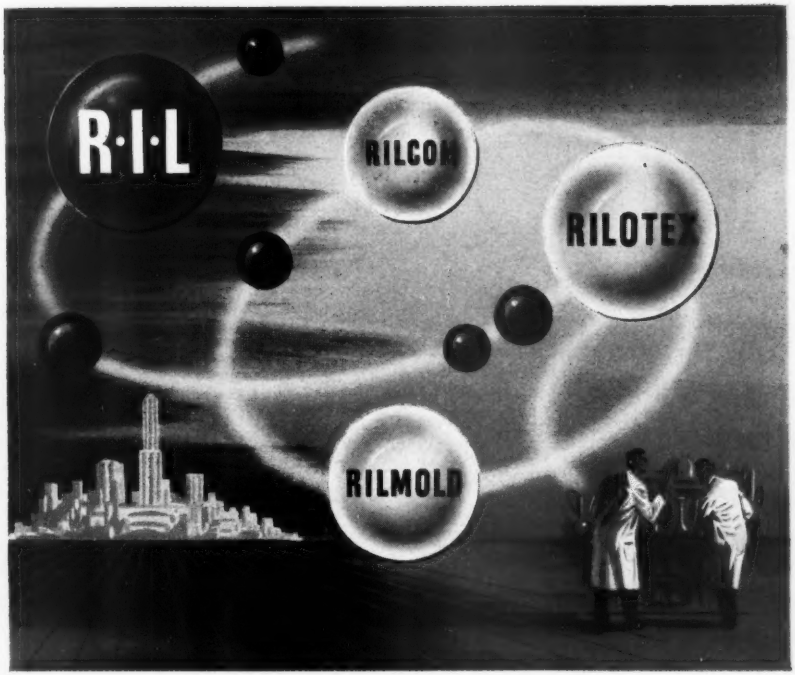

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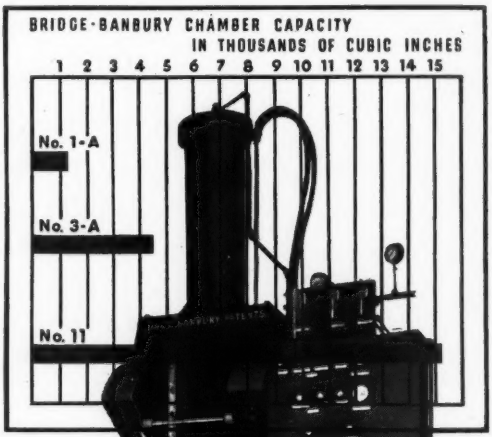

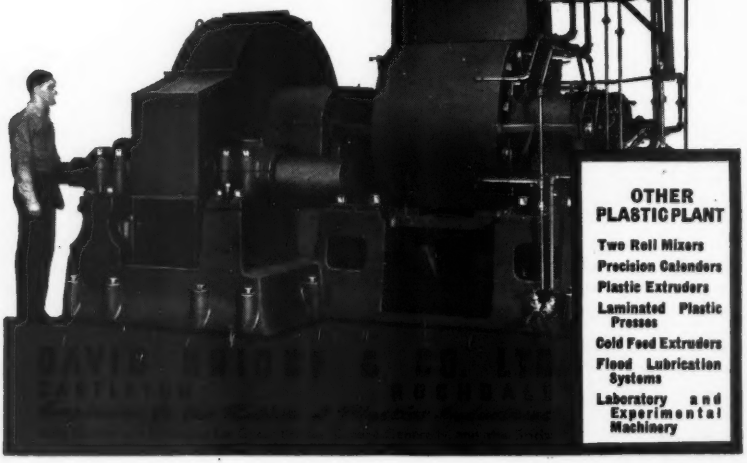

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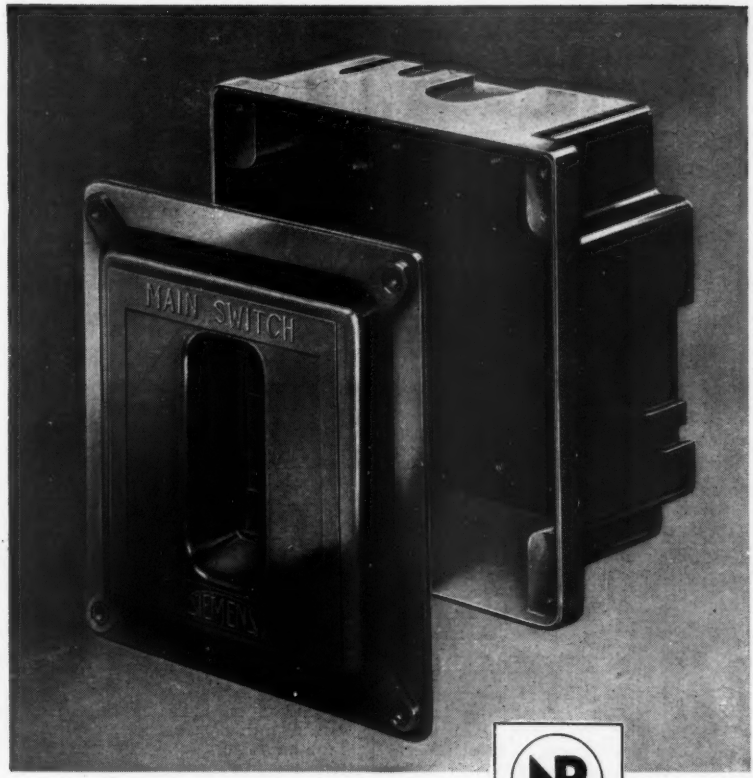

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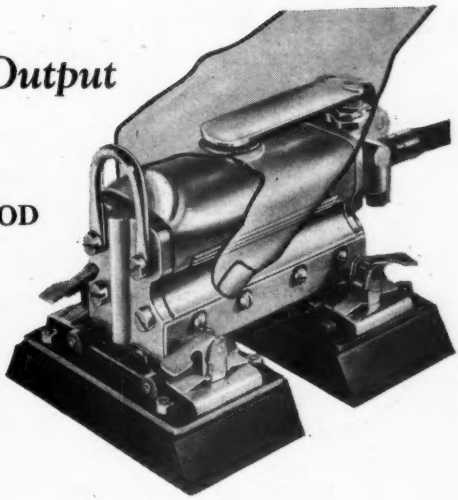

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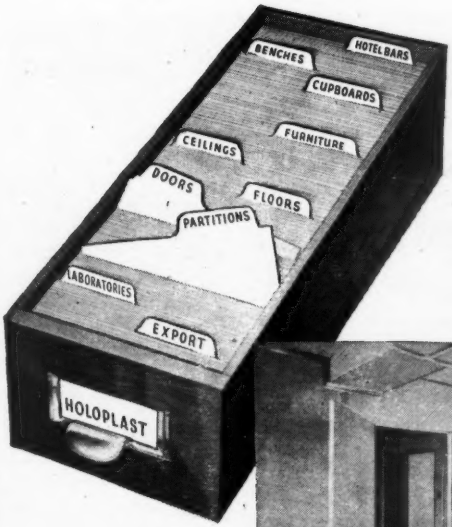

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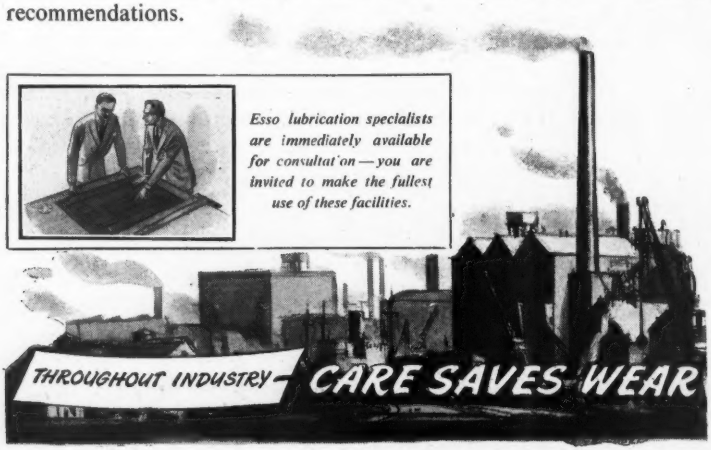

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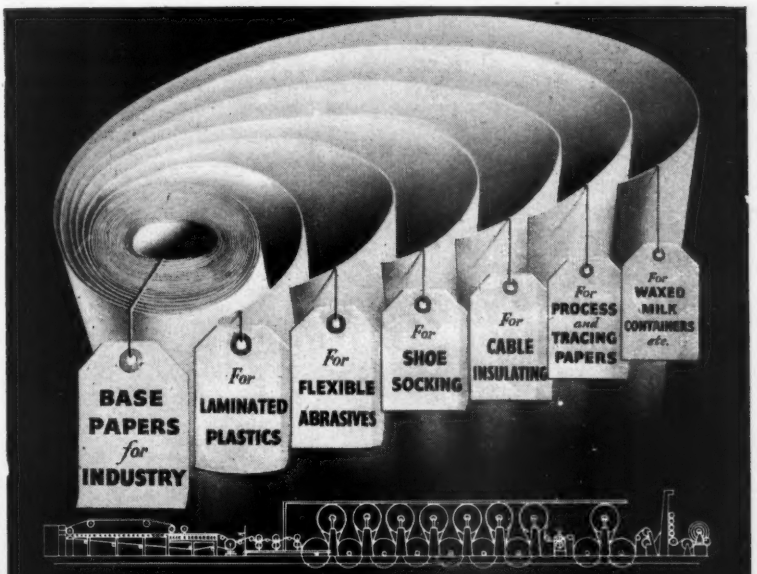

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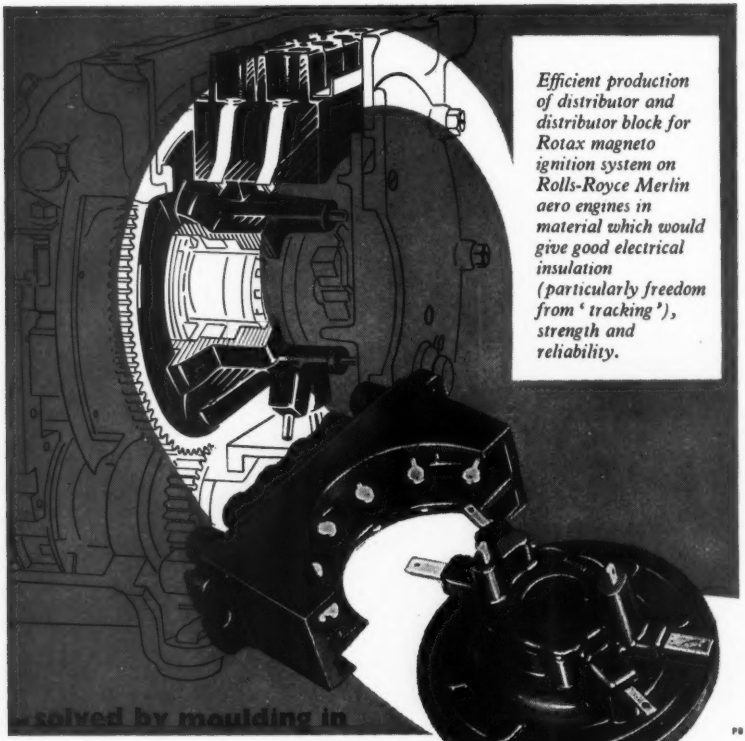

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Vol. XII. No. 138 NOVEMBER, 1948

Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

Proprietors - - TEMPLE PRESS LIMITED
Chairman and Managing Director ROLAND E. DANGERFIELD

Editor - - - M. D. CURWEN, B.Sc., A.R.I.C.
Offices - - Bowling Green Lane, London, E.C.1

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NOTICES

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EDITORIALS

Science and Production

OF the Presidents of the British Association during its 100 or so years of existence, Sir Henry Tizard has perhaps seen more of the impact of science on industry than any other. His presidential address at Brighton on the occasion of the 1948 meeting was appositely concerned with the productivity of this country and the part played by science in it. The result of his analysis is so disturbing as to warrant the closest attention of not only the Government but every manufacturer in every field of industrial endeavour. To-day, while the papers and the other organs of news and propaganda laud the wonders of science, it is a lamentable fact, and has been for very many years, that we are seriously lagging behind in applying those scientific discoveries to industry. With very few exceptions technology is at a low level.

The productivity of labour in Britain, he said, is far lower than it could be if the results of past research were more resolutely and continuously applied.

This is especially apparent in certain industries. In the coal industry the results are painfully obvious, for the coal raised per man is lower than it was 30 years ago when nearly all coal was hewed by hand. Research on building has been intense and fruitful, but are better houses being built with less labour than 20 years ago? Cotton research is of excellent quality, yet productivity in the cotton industry is lower than it was 15 years ago. Sir Henry pointed to the United States, to Switzerland and to Sweden as being exemplars in the application of science to industry and where productivity has risen at a much greater rate than in this country. This in spite of the fact that in the last two named countries many important raw materials were not indigenous. It was not that the standard of research in Britain is low, but that the standard of technology definitely is. Indeed, the speaker's view is that it is not the general expansion of research in Britain that is of first importance for its industrial health; what is of first importance is to apply what is already known. During the next 20 years the application of the known methods of economizing coal could bring more economical benefits than the production of power from uranium. Even in that advanced field, aeronautics, research has shown that air transport could compete with the train and ship. We must encourage adventures in engineering.

It does not need any profound research, Sir Henry Tizard continued, to show that the British industries that are now best standing up to the strain of adverse circumstances are the chemical and steel industries. Neither research nor development has been neglected and management is in the hands of men highly educated in pure and applied science. Both these industries are a source of great and growing strength to our economy. The same conditions of a high application of science exist in the most forward of industries in other countries.

In more recent years we have shown many weaknesses. It was not in the judgment of what to do, nor in the scientific work necessary to do it. It was when the stage of design and production was reached that we fell short. The magnetron which contributed more to the success of The Allies than any other invention was a product of British science, but it had to be redesigned in the United States for economical manufacture. Similarly, penicillin, the greatest practical achievement of medical science during the war, also originated in Britain but large-scale manufacture in the U.S.A. had to be undertaken, because of our inferior technology.

Pure invention still has its place; but

industrial prosperity will depend more and more on continuous application of science. Unless we can raise our standard of technology, unless there are many more men in executive positions in industry whose practical experience has been preceded by a scientific education, we shall inevitably fail to keep our place among the great manufacturing nations. On the other hand, if we are courageous and adventurous in science we shall reach new heights of prosperity.

Expansion of Production

FOR the first time in history, the importance of the plastics industry has been recognized officially by an announcement giving general details of the British four year programme, which was examined on October 30 in Paris by a working party composed of the Organization for European Economic Co-operation committee.

The programme, in addition to a plan to increase steel production from the present 15 million tons to 17½ million tons, and coal from 196 million tons to 250-260 million tons, includes two important sections relative to the future of plastics manufacture.

The first is that seven oil refineries will be built at a cost of £125 million and will be capable of treating nearly 20 million tons of crude oil, as compared with 2½ million tons in 1947.

The second is that a sum of £200 million will be spent on the development of the chemical industry and that the production of plastics will be three times that of 1938. In parenthesis, we are under the impression that our present production is about 2½ to 3 times that of 1938, so we may ask where the error lies. Certainly we ourselves believed in 1946, and last year one authority in a much better position to do so estimated, that our production was in the neighbourhood of 80,000 tons, which is very much over twice that of 1938. Perhaps it is an error in the year and that by 1952 we shall be producing three times that of 1948!

However that may be, it seems now assured that plastics production will be steadily on the upgrade. Polythene and polyvinyl chloride manufacture is being increased by I.C.I., Ltd., and we have already described the new works of Bakelite, Ltd., at Aycliffe, where both phenolic and urea powders and polyvinyl chloride will swell the total. Moreover, British Geon, Ltd., have introduced polyvinylidene and its co-polymers for the first time in this country. Then, again, we shall soon be having nylon for our moulding machines. Samples have already gone out and it is to be hoped that in six months bulk supplies will be available.

Such increases, coupled with the introduction of larger injection machines (we can now report a 40 oz. machine in the works of BX Plastics, Ltd., in addition to the 24 oz. at British Moulded Plastics, Ltd.), will no doubt lead to the development of larger sized products that have hitherto only been possible in metal.

All this will need increased production of raw material, but we must not forget that increased production in coal, in steel, in oil and in motorcars, in fact, any increase in production and erection of factories themselves means more prosperity in the plastics industry, for basically every electric light and motor, every temporary permanent construction, every cotton machine and every office contains something made from plastics.

The great economic change that has resulted from our decision to base our chemical production of the future partly on oil and therefore to bring it more or less on a par with coal as raw material, is reflected in this proposed increase in oil production, and refers in part to the new developments that will be carried out by Shell, Manchester Oil Refineries (through Petrocarbons, Ltd.) and I.C.I., Ltd. When these are completed, we shall see big production of polystyrene as well as of other plastics.

Taking all in all, it is not fantastic to presume that with the great expansion hoped for and the promised increase in housing we shall eventually need a production of not merely three times that of 1938, but three times that of 1948.

New Raw Materials

WE have already indicated that nylon is probably the next plastic to be placed at the moulder's disposal. It has been used commonly in the United States for some years and fairly commonly in France during the past year, but, while it has long been closely examined in small quantities here, bulk usage has not taken place because of the overwhelming demand for stocking manufacture. When it does come, and this seems probable within six months or so, ample use will be made of it.

Another and newer material is polytetrafluorethylene, which we first encountered in practical use at the 1948 B.I.F. It was used as an intermediate strip between electrical heater and polythene sheet on a polythene heat-welding machine, to prevent deterioration of the polythene at high temperatures. Its value in this respect can be judged by the fact that it only seriously decreases in strength over about 320 degrees C. and that it will not decompose under 400 degrees C., and even then does not carbonize. The monomer is made from chloroform.

These outstanding properties, and others, make it exceptionally important for the electrical industry, especially with the modern advance of electronics, with increasing use of the high-frequency band coupled with the requirements of aeronautical development. In polytetrafluorethylene we have a plastic with electrical losses lower even than those of polystyrene and polyethylene, while its resistance to surface arc-over is exceptional, for, with absence of carbonization, it leaves no conductivity paths.

Furthermore, it possesses outstanding chemical resistance to boiling alkalis and acids (even fuming nitric and aqua-regia does not affect it) so that we have also a new plastic for the chemical industry.

Much information regarding it is given by British Mechanical Productions, Ltd., who are now developing the material on an important scale in intricate shapes and various sizes for valve holders, cathode-ray tube holders, coaxial cable connectors, condensers and resistors, wave change switches, etc.

An excellent example of production by this concern is the B.7.G. valve-holder, one of the most difficult shapes to mould. It is now possible to mould them with inserts and to keep them to a tolerance of ±0.001.

Plastics Institute Lunch

ON October 8, a great gathering of members and friends at the Dorchester Hotel were welcomed by Mr. J. Lionel Daniels, Chairman of Council. His main object, which he carried out with great pleasure and considerable grace, was to welcome the President of the Institute, Mr. H. W. Graesser-Thomas, the guests in general and, special amongst them, Mr. Charles H. Breskin, proprietor of the well-known "Modern Plastics" of the U.S.A., and Mr. Hy. Nystrom, of Stockholm, who were greeted with loud acclaim.

Mr. Graesser-Thomas chose, as his presidential address, the subject of "Phenol," the production of which during the past years has been affected by the plastics industry to a much greater extent than it ever was by the dyestuffs industry and by the now dead picric acid explosives. Mr. Graesser-Thomas's address was in many ways an historical document of the progress made in phenol and cresol production in this country which led the world in this sphere and still retains its former ascendency. We have, therefore, considerable pleasure in publishing his paper on another page in this issue.

Mr. Charles Breskin

It is with considerable pleasure that we note that Mr. Charles Breskin will soon be in this country again. This will be on the occasion of the luncheon to be held at the Waldorf Hotel on Tuesday, November 16, at 12.30 p.m., when Mr. Breskin, who is technologist and observer of the American plastic scene in excelsis, will give a paper with the challenging title "Sell or Go Bust."

"Hall-mark" of Quality for Plastics

A NEW advance in the practice of providing reliable symbols of quality among industrial products takes the form of a certification mark for plastics and articles made from plastics.

This is intended to give purchasers an independent assurance that the marked materials and products conform to precise requirements laid down by an authority other than the producer.

The "Plastics Mark," in this vital and expanding industry, has comparable significance with the hall-mark that is affixed to articles of gold and silver to indicate their legal quality.

Certification of plastics is being developed from an agreed scheme between the British Plastics Federation and the British Standards Institution. The purpose is to ensure, by the allocation and use of the mark, that materials and articles made therefrom are correctly manufactured according to the relevant British Standards Specification.

The Certification Mark ("Plastics Mark") is in the form of a circle with the initials B.S. in the centre, indicating British Standard, and the initials B.P.F. on the left-hand side referring to the British Plastics Federation. In practical use, code letters and numbers on the right-hand side refer to the manufacturer and the specification concerned.

At present, the certification scheme is applicable only to moulding powders made from phenol-formaldehyde and urea-formaldehyde resins and certain mouldings made therefrom.

British Standards Specifications have been published for draining boards, lavatory seats and picnic-type tableware. Licences can be granted for the moulding of these articles from certified powders and in accordance with the relevant specifications.

Licences have already been issued to: Bakelite, Birkbys, British Resin Products, E. K. Cole, Ferguson, Halex, and I.C.I. As and when specifications are published for them, many other plastic materials and products will be included. From the present limited application will develop increasing opportunities for members of the public to see the Plastics Mark and to know that it always appears on an article of certain certified quality and suitable for its intended purpose.

But it is no mere label, likely to become obliterated or lost. The Plastics Mark is

either an integral part of a moulding or otherwise very firmly affixed, and it means more than a trade-mark backed only by a firm's reputation. It is proof that the plastics manufacturer is operating a system of control over materials and methods approved by the certifying authority.

This is a long-term scheme which, it is hoped, will gradually become universal on a great variety of consumer articles made in plastics materials as well as on household branded goods.

How the Plastics Mark is Licensed

Applications for licences, applicable to products for which British Standards Specifications are available, are addressed to the British Plastics Federation or to the British Standards Institution. The factories concerned are then visited by B.S.I inspectors to ascertain whether there are adequate testing facilities.

The B.S.I. Mark Sub-committee consider each application on its merits, and determine particularly from the inspector's report whether the suggested testing arrangements are satisfactory or need modification.

So far as moulding powder is concerned, an applicant will probably be asked to appoint a technical member of his staff to keep records and act as an inspector for the B.S.I. Statistical control charts will be required to be kept for some tests. For moulding powders, the following routine tests must be carried out and charted—powder density, cup flow test, cross breaking strength, and power factor.

An approved application will be forwarded to the applicant by the British Plastics Federation on receipt of the appropriate fee.

(Continued on page 618.)

The "Waco" Drilling Machine—and Plastics

Some notes on a new high-speed precision tool in which many main structural parts have been moulded from synthetic resin moulding powder.

THE plastics moulding industry quite rightly regards the entry of plastics into general engineering with extreme interest and of first-class importance, for obviously it is there that we can learn most of their suitability for purposes where mechanical strengths, resistance to abrasion, etc., are primary criteria. When they enter into the production of high-speed precision machines, the interest is the greater.

The news, therefore, that the "Waco" drilling machine is now being produced, utilizing a large number of phenolic-moulded parts of importance to its structure, is especially welcome.

The adoption of synthetic resin mouldings has been considered suitable not only because of the desire to avoid steel structures as far as possible but also because of their non-rusting properties, their high strength, their corrosion-resisting properties, and the fact that moulded resins avoid the necessity of metal working and subsequent treatment.

Manufactured by Walter Machines, Ltd., 1-3 King's College Mews, London, N.W.3, it is a super-sensitive,

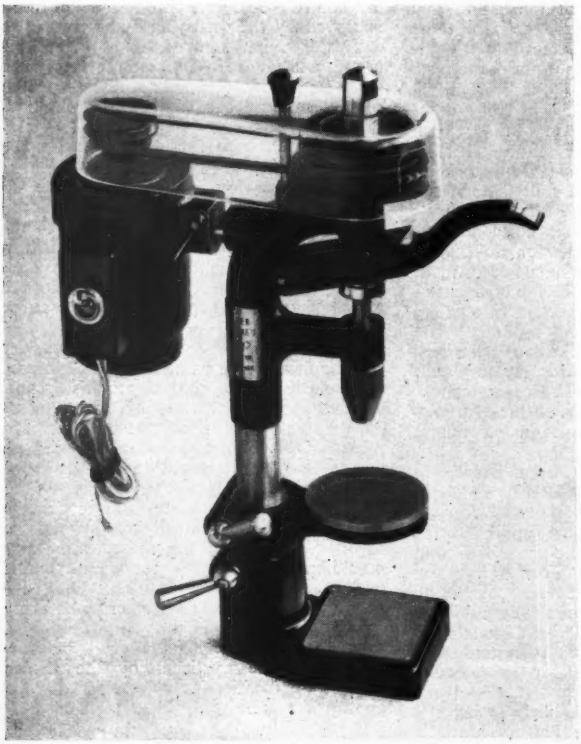

Fig. 1.—The new drilling machine is only 9½ ins. high and 7⅜ ins. overall width. The phenolic mouldings — base, pedestal, table, operating lever, step-pulleys and "Perspex" cover button —are all of black moulding material.

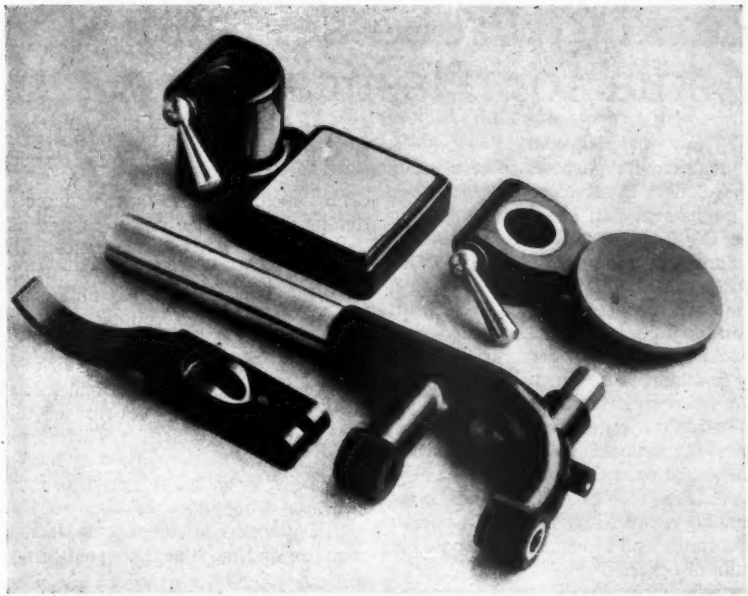

Fig. 2.—Close-up view of the dismantled four main structural mouldings—base, pedestal, operating lever and turn-table.

high-speed precision tool for watch, clock, instrument and jewellery manufacture in particular, but is obviously designed also as an accurate and reliable machine for general use.

The synthetic resin parts have been produced from phenolic moulding powders, designed for their mechanical properties, some of them of the fabric-filled type recommended for the job by Bakelite, Ltd. They include:

(1) The base which is fitted with a metallic plate moulded with the necessary metallic inserts, to support

(2) The pedestal, which, in turn, holds the thrust-races, spindle and the drill chuck itself, and to which is fitted

(3) The operating lever.

(4) Swing-round table, also moulded with metallic inserts.

(5) Step-pulleys for the driving mechanism giving three speeds, both protected by a "Perspex" cover.

It is proposed that future models will also be constructed with a plastic moulded motor cover. A combined base for grouping will also be included. The mouldings are produced in the works on three presses, one of which is a 50-ton Turner.

Fig. 2 shows the four main parts of the structure and the interesting moulding problems which the job entailed. Of special interest is the pedestal with its manifold metal inserts, and the operating lever provided with a cam action to maintain central pressure on the spindle thrust-race. The motor is 1/50 h.p., 20,000 r.p.m., giving 10,000 r.p.m. on the main spindle.

The whole apparatus weighs under 3 lb. and is extremely compact, being only 9½ ins. high.

This brilliantly conceived engineering job has been designed by Mr. W. C. Weilenman, who is a director of Walter Machines, Ltd.

Marking Processes and Media for Plastics—I

By E. E. HALLS

ON raw material, markings may be required for purposes of recognition or as an integral decorative pattern. On component parts, and finished equipment, they may be needed to represent a trade mark or customer's code, to provide operating instructions, to serve as a scale, to indicate connections or an electrical circuit diagram, or for one of many other reasons. Sometimes a temporary marking only is required—i.e., one easily removed when its purpose has been fulfilled, its elimination having to correspond with the return of the original surface in an unblemished condition. This requirement however, is the exception, and more generally a marking needs to outlive serviceability and to withstand all possible rigours of usage.

Regarding plastics, in some instances anticipated service life may be of limited duration and reasonably short, as with packaging materials such as plastic film printed with appropriate designs, nature of contents, and name of manufacturer. In other cases it may be of indefinite duration and relatively long, as with clothing, curtaining and similar furnishings of p.v.c. sheeting with printed decorative patterns. A third category includes applications where a definitely long life is required, as with the graduated scales of instruments, instruction cards and cautionary notices on machinery or electrical equipment.

Broadly speaking, in the marking of plastics to meet these needs, the desired service life itself does not play an important part in the choice of marking media and process. These are determined by such factors as the cost warranted for the marking operation, the nature of the plastic to be treated, the form in which it is to be marked, the quantity involved, and deteriorating conditions of service o which the marking may be subjected. These factors impose quite a number of limitations in themselves; as a result a marking that will withstand short service usually has to be of the same quality as one for long-term usage, although, of course, there are exceptions.

Phenolic resin-base materials will need to be dealt with either as sheets or panels, as machined components, or in moulded form; the same applies to the other thermosetting products. Thermoplastic resins require to be marked in the form of sheeting or sheets, foil or strip, tube or sleeving. They also have to be dealt with as panels and components, including moulded and machine-fabricated forms.

Methods Adopted for Marking

Methods of marking which are used include practically all known procedures, viz.: (*a*) Engraving, or engraving and filling; (*b*) stencilling, for example by spraying or by silk-screening, or by abrasive blasting; (*c*) solvent etching; (*d*) branding, including combined branding and printing with coloured foil; (*e*) printing processes of various types; (*f*) transfer processes, direct and indirect; and (*g*) photogravure and photographic methods.

The majority of these processes have in common the medium with which to produce the pattern. Broadly speaking, this will have a similar compositional complexity, whether it be used in mechanical fashion to fill an engraving, whether it is transferred to the material from a rubber roller or through the agency of a gelatine pad, or whether it is forced through the silk or wire mesh of a stencil.

In all cases the marking media, after application, must withstand the service conditions of the job. They must be of suitable consistency for application with-

out becoming tacky or drying prematurely ; they must dry rapidly when applied, and the dried films must adhere well.

Generally the desired colour must be provided by a dye or pigment. This has to be bonded to the plastic base ; hence it has to be uniformly incorporated in a suitable plastic binder and carried in a vehicle to suit the processing conditions ; the vehicle, of course, is finally disposed of by natural or forced evaporation, or by absorption into the surface treated. Other modifying agents may be present to suit conditions of application, or to impart specific qualities. For example, driers may be used to hasten the setting, special solvents to promote merging with plastic surfaces, and rubber, wax or lanolin to impart specific properties in printing processes.

Desirable Qualities of Pigments and Dyes

Pigments or dyes, apart from being fast to light and stable under service conditions, must not bleed into the plastic, nor into the solvent vehicle. For application to thermosetting materials, the selection of the plastic binder to give sound adhesion is fairly straightforward, with no complications arising from plasticizers. In the case of thermoplastic materials, however, it is desirable to ensure merging or welding with the plastic base, otherwise there is a danger of plasticizers in the latter migrating from the plastic base to loosen the bond of the printed design.

For inks to print well and adhere tenaciously to the smooth surfaces of plastics, Wolfe (" Printing and Litho Inks," Macnair Dorland, 1941) states that it is necessary they should be specially formulated. He points out that ordinary linseed-oil-base litho and typographic inks do not possess the required properties of adhesion, hardness and toughness. For plastics, printing inks usually contain a hard-drying synthetic resin dissolved in linseed, perilla or china-wood oil. Among the resins chosen are the modified phenolics and the hard-drying alkyds. Generally, it is said that a vehicle prepared from 25 per cent. of the resin and 75 per cent. of the oil, by heating these two constituents together, is satisfactory for most purposes. After the mixture is cooled, it is beneficial to incorporate a little strong solvent, to the extent of about 10 per cent. This solvent should be of high boiling point and selected in accordance with the nature of the base material ; its inclusion is for the purpose of obtaining a better grip upon the surface of the plastic, and butyl cellosolve is quoted as an example.

Wolfe also advocates ordinary hard-drying spar varnish as an ingredient in inks for plastic surfaces, because it is admirable for imparting adhesion and waterproofing properties. The addition of this agent is preferably made after completion of all the grinding operations on the ink, and therefore avoiding loss of solvent from the varnish unnecessarily.

Preparation of Printing Media

In preparing inks from these synthetic resins, special care has to be taken to avoid " livering," which is prone to occur on account of the relatively high acid values of the synthetic resins used. If certain pigments are used, such as sulphides and many of the oxides, reaction between them and the acidic resins is likely to result.

Inks for nitrocellulose base plastics must in particular possess high covering or obliterating power. Much work printed on this material is covered with clear varnish or lacquer, and therefore it must be remembered that the print, and especially the pigment in it, must be fast to the solvents in this overcoating varnish. Industrial methylated spirit is one of the commonest solvents encountered in this respect, and it is one very likely to cause bleeding if a wrong pigment has been chosen.

The use of highly obliterating inks may mean a concentrated medium, and this may reduce adhesive properties. This difficulty can be offset, and the

trouble eliminated or minimized, by the addition of a little camphor, amyl acetate, acetone or similar solvent for nitrocellulose. Wolfe also notes that to produce a printed pattern on polished celluloid it is desirable to print on the dull material, and subsequently polish, in all cases where this sequence of operations is permissible. For this, the printed dull material is placed between nickel plattens under high pressure at moderate temperatures. The same procedure is applicable to cellulose acetate.

Chatfield ("Varnish Constituents," Leonard Hill, 1944) mentions the use of modified phenolic resins (i.e., phenol-formaldehyde condensation products modified with natural resins or natural oils) in printing varnishes.

Heat-liquefied rubber, as an addition agent, is referred to in U.S. Pat. 2,120,393. This material is prepared by heating raw rubber to temperatures in the neighbourhood of 300 degrees C., when liquefaction and darkening occur. The resulting product possesses drying properties when driers are present, but exhibits poor durability because the final film has a strong tendency to develop cracks upon exposure. This shortcoming is offset by adding some linseed oil to the molten rubber.

Oxidized rubber included in printing inks gives an improvement in the gloss and drying characteristics, and larger proportions have a matting effect. The oxidized rubber is known as "rubbone." It is prepared by oxidizing rubber in a solution in benzene, carbon tetrachloride, chloroform or white spirit. The oxidation is achieved at 50 to 90 degrees C. by a stream of oxygen, air or ozonized air, in the presence of catalysts, such as the oleates, tungates, linoleates or resinates of cobalt, manganese, lead and copper. The linoleates and tungates become precipitated during the oxidation process, and can be removed by decantation, filtration or centrifuging; the solvent is removed by evaporation. Rubbone appears to be a beneficial addition, because it possesses good durability as well as flexibility, waterproofness and chemical resistance.

Waxes and lanolin are sometimes chosen as additions in overprinting varnish for preventing penetration and modifying tack. Straight wax pigment mixtures are used for printing on absorbent surfaces (e.g., for oxidized aluminium, 10 per cent. chromium oxide in paraffin wax). They would be unsuitable for smooth plastics. For lithographic inks, U.S. Pat. 2,018,060 covers a composition for small additions to produce modified properties; this mixture is one of phenol-formaldehyde resin, tung oil and lanolin.

Printing on P.V.C.

Printing on p.v.c. sheeting has become an important process due to the wide use of this material for furnishings which need decorative coloured patterns. One of the major difficulties encountered in obtaining adherent and durable printed markings on this material is due to the migration of plasticizer, which may loosen the bond. Vinyl resins, such as the acetate, or acetate/chloride copolymer, used as the basis of inks, should solve this problem provided they contain sufficient solvent of a nature to "bite" the base material and permit true welding of the ink with it. Methylene chloride is such a solvent. However, it is desirable for the vinyl resin base of the ink to be of the same composition as that of the sheeting to which it is to be applied. In this respect both ink and sheeting should contain plasticizer in similar amount and of the same kind.

Inks formulated in accordance with Wolfe's recommendations, i.e., drying oils incorporated with modified phenolic resins or with alkyd resins, should also prove useful for application to p.v.c., provided the proposed solvent addition is a solvent for p.v.c.—for example, methylene chloride or difurane may be employed.

Composition of Printing Inks for Plastics

Formulæ for various types of ink for the cellulose plastics which confirm the

desirability of embodying a solvent for the base plastic are set out below :—

(1) SIMPLE WRITING INK FOR CELLULOSE NITRATE AND ACETATE

A 20 per cent. solution of tannic acid is prepared in acetone, and mixed with a 20 per cent. solution of ferric chloride in acetone.

(2) PRINTING INK FOR CELLULOSE ACETATE

U.S. Pat. 2,165,522 covers the incorporation of appropriate pigment in a mixture of glycerin (5–15 per cent.) and glycol monacetate (85–95 per cent.).

(3) ROTOGRAVURE INK FOR CELLULOSE PLASTIC FOILS

From 1–3 per cent. of cellulose acetate and appropriate colourant (e.g., 3 per cent. Victoria Blue dyestuff) are incorporated in a solution of shellac composed of shellac flake (150 gms.), acetone (50 ml.), benzol (50 ml.), and industrial methylated spirit (200 ml.).

(4) PRINTING INK FOR RAYON RIBBON

High viscosity ethyl cellulose ($\frac{1}{2}$ oz.) and industrial methylated spirit ($\frac{1}{2}$ pint) are allowed to soak for 20–30 mins. until a gel forms, and then the following ingredients are incorporated : Tributyl phosphate (1/5 oz.), Surfex ($\frac{3}{4}$ oz.), Titanox ($1\frac{1}{2}$ oz.), and magnesium carbonate (1 oz.). The pigments can be replaced by other colourants. Methylated spirit can be used to adjust the consistency to satisfy individual needs.

(5) CELLULOSE PLASTICS TRANSFER INKS

A number of transfer inks for cellulose plastics are of interest :—

	Parts by weight
(a) Cellulose acetate	170
Triacetin	200
High phenol resin	200
Pigment	250
(b) Nitrocellulose ($\frac{1}{2}$ sec. viscosity)	15
Triphenyl phosphate	20
Blown castor oil	5
Basic dyestuff	2
Acetone	50
(c) Nitrocellulose ($\frac{1}{2}$ sec. viscosity)	15
Glyptal balsam	20
Stearic acid	5
Pigment	10
Acetone	50
(d) Nitrocellulose ($\frac{1}{2}$ sec. viscosity)	15
Phenol formaldehyde resin	25
Beeswax	50
Acetone	50
(e) Cellulose acetate	50
Triphenyl phosphate	50
Butyl tartrate	50
Mineral oil	5
Basic dyestuff	20
(f) Ethyl cellulose (high viscosity)	50
Castor oil	25
Mineral oil	10
Bronze powder	20
Benzol	50

It will be noted that these formulations cover bases of cellulose acetate, nitrocellulose and ethyl cellulose, that phenolic and alkyd resins are included in some of them, and that an oil constituent is incorporated.

These printing processes are required for decorative purposes in applications where long service life is expected without any marked deterioration ; in other cases they are needed where colour serves a definitely functional role. The choice of colourant is deemed to be highly important, for compatibility with the plastic has to be considered. In many cases, again, the " printing material " must be extended with solvent, so that solubility or insolubility in the normal materials employed for this purpose, as well as bleeding into such solvents, requires study. Further, fastness of the colour to light and behaviour under the action of deteriorating agents, such as moisture, oil, grease or chemicals, have to be taken into account.

In short, the same rigorous requirements obtain for the colourant in the marking material as for the dye or pigment in the coloured plastic itself. Indeed, the establishment of efficient colouring materials to satisfy service requirements has proved to be no simple matter. W. H. Peacock and R. H. Kienle have presented a very good summary of features appertaining to this problem in " Modern Plastics Encyclopedia," 1946.

Hot Marking, Roll Leaf, and Hot Branding Processes

Hot branding, gold blocking, roll-leaf hot marking and pigmented foil printing are closely associated processes having the same fundamental principles. The marking ink is in the form of a plastic bonded

colourant carried on one surface of a paper carrier. The marking or pattern required is pressed upon the job at a controlled temperature by means of a metal die. The equipment used varies with the nature of the work, but in all cases the pattern may be pressed into the material to a controlled depth in such a way that it is positioned virtually on the surface of the material or fully sunk in it.

Actually the process can be applied quite successfully to metal, plastic-coated metal, or plastics. Adhesion of the imprinted coating can be excellent, but naturally the apparent adhesion or tenacity decreases as the difference in hardness between the base material and the plastic-bonded pigment increases. Thus, for a superficial coating, that on the surface of metal can be scraped off, whereas that on a thermoplastic material cannot easily be removed without damaging the base material. In short, in the harder materials, such as metals and the thermosetting resin plastics, it is advisable to press sufficiently heavily to sink the marking into the material so that it shall be flush with the surface. With thermoplastics, such as polyvinyl chloride and cellulose acetate, this is not essential.

These hot-branding processes can be applied to sheet, foil, strip, rod and tube forms of material, or to components in the form of flat panels or simple shapes, such as tubular or spherically curved articles. In the latter cases, the quantity of work to be performed is a primary determining factor in considering whether such a process can be adopted. The pigmented foils can be supplied in sheet or roll form of suitable width to provide the most convenient and economic form for individual purposes.

Branding processes virtually combine the operations of engraving the pattern and filling it with wax or paint filler. Apart from advantages of speed by combined operation, and pressing instead of expensive engraving, there are others which provide for economy, efficiency and quality. The "filling" by branding is accurate, and patterns (i.e., wide areas) that could not be easily and neatly filled in engraved work, may be thus reproducibly executed. There is no excess paint or wax to remove; there is no shrinkage of the marking during a drying period, and no such drying period. The printed work is ready for the next operation, or for packing, as it leaves the branding press.

Details of press design vary somewhat with different processes and upon the nature of the work to be processed. In the generally adopted form of marking press the heated dies are carried in the head of the press, and can be lowered on to the work, which is fed across a platform or placed in a suitable location beneath the head. The pigmented foil is fed between the die and the work. The press is set appropriately so that by lowering the head to a stop, the work is indented to the required depth, at the same time transferring the colour from the foil into the indentations of the pattern.

The maximum heat employed in the die corresponds to a temperature of the order of 120 degrees C. It has to be determined by trial to suit the material which is being marked and also the speed of operating. Thermostatic control is provided. Dies can be of brass, mild steel or hardened steel. The latter is used for harder materials and for long runs, and the brass or soft steel for thermoplastics and short production schedules.

Presses may be manually operated, semi-automatic, or fully automatic, according to the nature of the job. The feed mechanism on the coloured foils allows the precise length of foil to be fed, thus avoiding wastage. For curved surfaces, rotary stamping presses can be used; here the article is rolled beneath the surface of the die, the minimum of contact surface being involved, and therefore the lowest operating pressures are practicable. This method can be extended to the marking of plastic-covered wire, and it can be adapted to the simultaneous marking and blanking of small components from plastic sheet, such as vulcanized fibre, cellulose acetate, etc.

(To be continued.)

World's Industry Employs Plastics

GENERAL ENGINEERING

Plastic rings for assembly.—For connecting machine parts, in particular of cylindrical shape, it is suggested by M. Reichner to provide both the shaft and the bore with a cylindrical recess and, in addition, the housing carrying the bore with an opening. Through this opening a plastic material is pressed in, for instance, by a usual spray gun. The surface of the recess may be quite rough to give a good binding. (" Werkstatt and Betrieb," 1948/July/184.)

Phenolic core binder.—A new phenolic resin for binding sand cores gives these enough dry strength to be handled while still warm. With a minimum baking time and temperature, the core has sufficient strength to withstand pouring temperatures of 2,750 degrees F. (1,500 degrees C.). Very little gas during pouring developed. (" Machinery," N.Y., 1948/Aug./181.) Producer: General Electric Co., Chemical Dept., Pittsfield, Mass.

Processing plastics.—Illustrations and short description of seven new American machines for the processing of plastics as exhibited at the Third National Plastics Exhibition, New York, Sep. 27-Oct. 1, 1948, include the Van Dorn Iron Works and Reed Prentice Corp. hydraulic injection machines, F. J. Stokes 50 tons compression-moulding press with automatic feed, Watson-Stillman inverted-ram transfer moulding machine, Defiance Machine Works preform press, Peerless roll-leaf stamping press, and Girdler Co. high-frequency preform heater. (" Machine Design," 1948/Sep./154.)

Strain test for rubber compounds.—W. L. Holt and others describe a tester for measuring the strain of rubber vulcanizates when subjected to a predetermined stress. Special apparatus for cutting and measurement of the test specimen are described. Routine determinations of a point on the stress-strain curve can be made, being an improvement over measurements hitherto carried out. (Journ. Res. Nat. Bpr. Standards, 1948/Aug./95.)

ELECTRICAL

Printed circuits on plastics.—In new hearing aid, made by Telex Inc., Minneapolis, U.S.A., a circuit printed in silver is placed on polystyrene wafers $1\frac{1}{8}$ ins. long and 15/32 ins. wide. Formerly a ceramic base was used, but new design gives increased lightness, flexibility, durability and imperviousness to humidity conditions. (" Materials and Methods," 1948/Aug./73.)

Electrical properties of plastics.—A knowledge of the dissipation factor and dielectric constants of plastics owing to the many electrical uses of plastics is as important as a knowledge of heat-distortion point, tensile strength and resistance to outdoor weathering. A. J. Warner, based on the theory of dielectrics, made some investigations mainly with polyetrafluor ethylene under varying conditions. He demonstrates that electrical test methods can be effectively used to improve materials. (A.S.T.M. Bulletin, 1948/Aug./60.)

Rubber insulation improved by water. Electrical wire covered with a special rubber insulation improves when soaked in water. A dip-coating of high purity natural rubber latex gives high durability. A specimen wire was immersed in water at 122 degrees F. for 24 weeks. Insulation resistance increased from 500 to 2,400 megohms. ("Machinery," N.Y., 1948/Sept./179.) Producer: United States Rubber Co., New York City.

MISCELLANEOUS

Reclaiming synthetic rubber.—Some highly alkylated phenol-sulphides appear to be most active reclaiming agents for GR-S and other synthetic rubbers. The activity as related to molecular structure and to the action of sulphur during the reclaiming process is discussed. ("Industrial and Engineering Chemistry," 1948/July/1194.)

Laminated Plexiglas.—W. F. Burtoe and E. N. Robertson report on recent developments in the laminating of Plexiglas (methacrylate sheet) with polyvinyl butyrol interlayers. Present practical limitations are discussed and, in particular, the uncertainty of control of interlaminar adhesion. Graphs show light transmission characteristics, temperature softening, and stress-strain relationship. For good properties, i.e., low notch sensitivity and optimum optical qualities, a low degree of interlaminar adhesion is ideal. ("Aero Digest," 1948/May/42.)

Marking plastics.—The brittleness of certain plastics makes marking a problem. In the "Acromask" system the workpiece is immersed in a thin oil during the engraving process. This process has been extended to stamping and rolling with properly constructed dies and machines, electrically heating the die; colour transfer tape being fed automatically between die and component. Method applicable for thermosetting plastics, amorphous and crystalline thermoplastics, baked enamel-coated metal and light metals. ("Machine and Tool Blue Book," 1948/Aug./158.)

Polishing plastics.—To a reader's query, it is replied that plastic components generally have a sufficient surface finish by moulding; when polishing is necessary, a calico or leather mop wheel should be used with a paste of putty powder (tin oxide) and water, alternatively, alumina powder or other good abrasive can be used. Information is also given on adhesives. ("Practical Engineering," 1948/Oct./324).

Automobile glazing with plastics.—Extensive tests have been undertaken by G. B. Watkins and J. D. Ryan with plastic windshields. Their conclusions are that plastic glazings are difficult to clean and road scum does not wash off easily. Windscreen wipers are not so effective, as water does not wet the windscreen. The windscreen wiper, by its rubbing action, attacks the surface. Heaters are not so effective as with laminated glass. Plastic glazing tends to rattle. This shows that plastic glazing is not yet developed technically to replace glass. (A.S.T.M. Bulletin, 1948/Aug./65.)

Cast resins.—A short but general review on phenolic resins for casting, their moulds, moulding process, etc., are given by M. Apley. ("Machinery Lloyd," 1948/Sept./67.)

Non-metallic gears.—The production stages in making gears of plain, unwoven cotton, without binder, are described by K. Rose. These gears, different from the usual laminated gears, are for heavy-duty purposes with noiseless operation. Data on safe working stresses in relation to pitch-line velocity are given. ("Materials and Methods," 1948/Aug./68.)

Impressions of the New York Plastics Show

By Our Correspondent in U.S.A.

THE Third American National Plastics Exposition was opened at the Grand Central Palace, in New York, on September 28 and lasted until October 2. Although this exhibition was only open to people from the trade, there was a record attendance of 40,000 people during these five days. One hundred and thirty different companies exhibited, covering something like 250 stands. In view of the size of the exhibition, the writer can only hope to touch on those features which to him personally seem most impressive and worthy of note.

True to the American manner, those objects which were chiefly remarkable for their size will first be described. The U.S. Navy showed a plastic boat, which they claim to be the largest single plastic object ever to be moulded in one piece. This was an indestructible personnel carrier, 28 ft. 9 ins. long, with a beam of 10 ft. The boat is capable of carrying 22 men and can do better than nine knots. It was constructed of a laminated fibre glass material manufactured by the Winner Manufacturing Co., Trenton, N.J.

The other very large item was a piece of water-clear Plexiglas sheeting, 100 ins. by 120 ins. by $\frac{1}{8}$ in., exhibited by Rohm and Haas Co. This company exhibited many other beautiful items made from Plexiglas; for example, they showed large, extremely effective display items in normal and fluorescent acrylic sheet. There was corrugated Plexiglas for lighting and screening purposes, plain or cast with patterned surfaces to avoid complete transparency where necessary. Rohm and Haas also displayed a new heat-resisting variety of polymethyl methacrylate moulding powder, objects moulded from which will stand immersion in boiling water without distortion.

The most interesting item of display on the stand of the Hercules Powder Manufacturing Co. was a new type of flame-resisting cellulose acetate. This material has good dimensional stability and yields products of consistently high quality. Products made from this material include electrical hand-drills, portable vacuum cleaners, which are very light in weight. the hand-drill is, therefore, less tiring when used for a prolonged period of time, the insulating properties of the plastic eliminate all dangers of shock, and the durable finish is long-wearing and will not peel, chip or erode. The vacuum cleaner is attractively treated with a finish that keeps its good appearance, and it will not scratch furniture or delicate fabric. The company also exhibited tool handles made from ethyl cellulose, which are said to be new and replacing nitro-cellulose. There were many other items, such as radio cabinets and luggage, made from laminating cloth between two clear sheets of acetate. This material is also finding use in permanent drapes and automobile interiors. Television masks made from ethyl cellulose were also shown. Further, there were a number of extremely ingenious cellulose acetate moulded toys, including completely moulded plastic dolls, a tiny washing machine which actually washes tiny clothes, and a miniature juke box, which plays a tune on insertion of an appropriate coin. These last two items were both only a few inches square and were fascinating to watch. Other items from cellulose acetate included such rare things as fish lures, hearing aids, fluorescent light shields and sanitary crib rims of extruded cellulose acetate.

Tenite extruded sheeting and its fabrication featured the exhibit of the

Tennessee Eastman Corporation. Colourful "give-away" boxes were actually formed on the stand from extruded sheeting by an ingenious one-operation forming machine. There were also scale models of Ford automobiles, moulded from Tenite and run by remote control. A portable radio housing, one of the first commercial products to be made by laminated Tenite and a fabric core material, as well as several examples of Tenite-coated tubing were on display.

A wireless translator system which is used in the United Nations sessions was demonstrated by the Celanese Corp. This firm also exhibited Lumarite XF, a new heat- and flame-resistant form of cellulose acetate, being a bridge between the thermoplastic and thermosetting types of resins, and particularly adapted for use by the electrical industries. It is an economical high-speed moulding material of shatterproof toughness, good colour range, and excellent retention form, and is, besides, outstanding for its lack of brittleness and the ease with which it can be moulded. It is used for many different purposes, notably for electric shaver housings, vacuum cleaners, and housings for electric stirrers.

The Catalin Co. featured an attractive stand, displaying, among other items, beautiful injection-moulded wineglasses in transparent polystyrene and glass-clear polystyrene building blocks. It was announced by the company that they now include more than 24 items in their architectural plastics lines. The use of plastics in this field eliminates the need for annual repainting or refinishing of many interior trim items.

A number of extremely interesting items were to be seen at the stand of Du Pont de Nemours. Some emphasis was given to Teflon, the latest Du Pont plastic. Uses for this material which were shown, included valve parts, gaskets and pump packing, where the good chemical resistance of the material is exploited, and also for covering the jaws of heat-sealing equipment to prevent sticking. In the form of tape, Teflon is used for electrical insulation for motor windings, transformers, etc. It was stated that the safe operating temperature at which it can be used is from 500 to 550 degrees F. In appearance it is slightly milky-white, looking and feeling somewhat like polythene. Further, there were large television lenses in Lucite and television filters in cellulose acetate film. Much space was given to polythene, used for such items as bottles and flexible ice-trays. The latter are now in common use in the United States, their flexibility making it easy to eject the ice-cubes. There were pipe fittings in polythene; raincoats and tablecloths. Polythene film has also been adapted by the company as a packaging material for frozen and fresh goods. This has already been much publicized; for instance, a whole frozen turkey was displayed in a polythene flexible bag. The importance of nylon as a moulding material was emphasized, and items exhibited included super-strong hair combs which can be sterilized in boiling water, and a number of small cog and gear wheels from the same material.

Another very fine stand was that of the Bakelite Corp. They featured plastics for home decoration, including large moulded phenolic cabinets. These were moulded in England by Runcolite and sent over for the exhibition. In rigid vinylite, compression - moulded long - playing gramophone records were shown. These play for 45 minutes on each side. In the same material there were playing cards and drawing instruments in transparent colours. Water-clear umbrella covers made from polyvinyl chloride, car hoods and garden hoses made from flexible polyvinyl chloride, were also shown. Foundry-board patterns made of a compressed wood covered with a special phenolic coating were specially featured, and stated to be finding wide use in industry, being cheaper than those hitherto used. New light-weight metal or wood-surfaced laminates, which included metal foil surface laminate which is proof against cigarette burns, were also of interest. Polystyrene was shown as used

for battery cases, and polythene for dishes and bowls for household use. A feature of the latter is that the flexibility of the material makes it possible to use the lids as vacuum sealing lids.

B. F. Goodrich Co. gave a good showing of Geon resins, including cast polyvinyl films made by the Plastic Film Corporation. Among the uses displayed for this material were washable picture books for children.

Among the new items featured by the Industrial Synthesis Corporation was a garden hose made of Elastron, a polyvinyl chloride with aluminium powder as a pigment. The aluminium reflects ultra-violet rays, prolonging the life of the hose.

Some very effective items featured by the Columbia Protektosite Co. were partition blocks, made from polystyrene and provided with special interlocking ribs. These ribs lock invisibly behind the adjoining block and make rigid assembly a high-speed operation. These blocks are only one-fifth the weight of glass blocks, and the injection moulding makes them especially accurate and uniform. They are made in both transparent and opaque faces, and offer the decorator a great variety of colours and designs. They freely admit the passage of ultra-violet light and make an exceptionally strong and durable structure.

Very interesting also were many of the articles displayed by the Goodyear Co. This company has now ready for the market a new family of high impact strength plastic compounds prepared from Pliolite resins and plasticized with rubber, known as Tuflite. Pliolite can be either a cyclized natural rubber or a styrene-butadiene product. Tuflite has a very high impact strength, is light in weight, and allows for a wide colour range. Among its many applications shown were golf-ball covering stocks, football helmets, golf-club heads and bowling pins. Highly-loaded Tuflite compounds show great promise for cutting blocks in the leather industries.

The Dow Chemical Co. showed two new materials for the first time, Styron 475 and Styron 637. The former is a rigid and tough thermoplastic, similar to polystyrene, except for higher impact strength and greater elongation. The latter is lower priced, has improved light stability and has a useful life before colouring, amounting to several times that of polystyrene.

The Plaskon Division had on display their product, Plaskon-alkyd, which is a thermosetting moulding compound of excellent electrical properties, unique moulding properties, high heat resistance, low moisture absorption and superior dimensional stability.

A large number of injection moulding machines were also on display at the exhibition, including a new HPM 40-oz. injection machine and a new Van Dorn machine. There was also a great deal of high-frequency preheating and welding equipment. For instance, two different varieties of electronic welding machines were exhibited, one by Union with rotary seaming electrodes, and one by Singer.

A number of firms showed examples of the new woven fabric, Saran. This was displayed in extremely attractive colours and patterns, and is especially useful for such applications as automobile seat coverings. As a matter of fact, most of the latest models of American cars have this material for their seat coverings.

All in all, it was a highly successful show, put on with great care and with one or two exceptions in very good taste. The record attendance figures speak for themselves, and it was easy to see that the exhibition was a great success from the point of view of drawing people both from the home trade and from overseas. On the other hand, there was little that could be described as startlingly new, and the exhibition tended to give the impression that the plastics industry was settling down to improving existing products rather than trying to invent new ones. There appeared to be rather less literature available this year, particularly as lavish literature is usually a common feature in American trade exhibitions.

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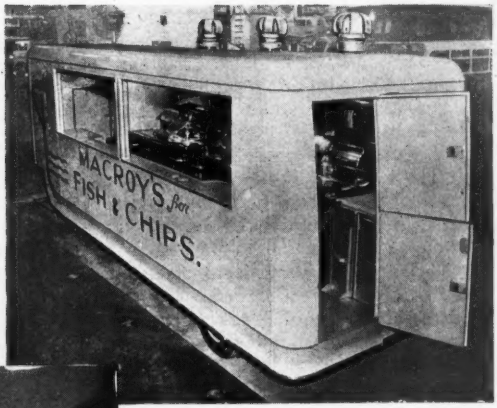
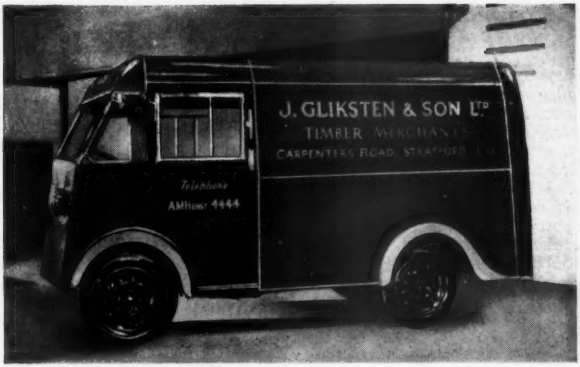
Plastics at Commercial Motor Transport Exhibition, London

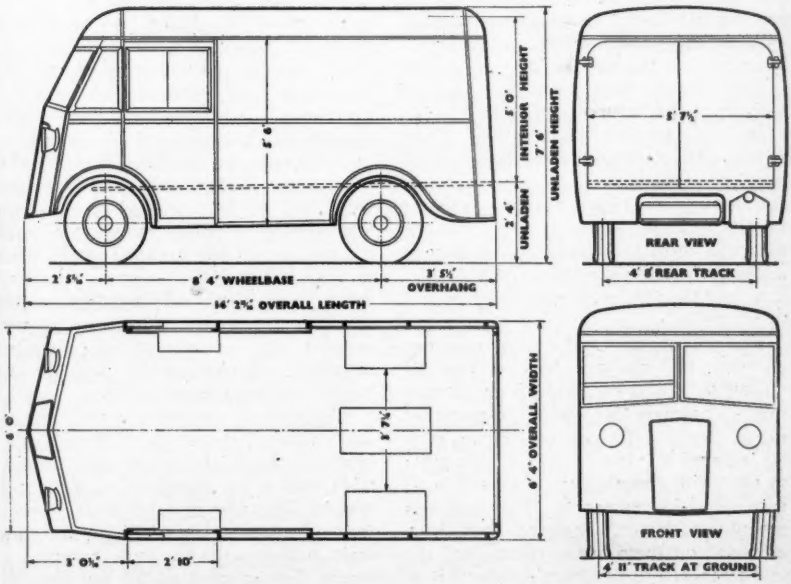


(Above, and left) The interior of this mobile "fish and chips" shop, complete with frying equipment, chip-cutting machines and serving counter, is lined throughout with "Formica" laminated sheet of bluish-grey marbled design. This material was chosen for the reason that the surface is non-absorbent, easy to clean, and does not scratch—all excellent qualities in such a situation where the atmosphere would carry a great deal of grease-laden steam and the smell of frying fish and chips. Mounted on a Dyson 3-4 ton drop frame trailer, this mobile shop was seen at the stand occupied by R. A. Dyson and Co., Ltd., trailer builders, 76-68, Grafton Street, Liverpool.

(Right) The coachbuilt cab of the Mark III (semi-trailer) Tractor Unit, by Proctor Springwood, Ltd., Mousehold, Norwich, has rear corner windows which are correctly positioned to give in tant view of both sides of the body or trailer. Curved sheets of "Perspex" are used for these windows. With a load of anything up to 8 tons, perfect rear visibility from the driving seat is very de.irable for safety.



The box body of this delivery van, which was exhibited by The Cunard Commercial Body Building Co., of Abbeydale Road, Wembley, Middlesex, mounted on a 15/20 cwt. Morris Commercial P.V. chassis, has been designed with "Holoplast" laminated panelling as constructional material. The roof from front to rear (in one panel) side panels, front and rear doors, and also the floor, are all of "Holoplast." The body of the van has a capacity of 270 cubic feet. The domed roof, a slight barrel to the sides, and sweep-down front, combine to present a pleasing design, with no indication whatever of the use of this new laminated panelling material. Details of construction are shown in the accompanying drawing.



Recent Progress in Silicone Rubber

Among synthetic rubbers which became commercially important during the war years, the most unusual in properties and performance was silicone rubber. It appeared on the American market late in 1944, and has now been available to British users for nearly three years. The following information regarding this comparatively new synthetic elastomer is abstracted from a paper by S. L. Bass, of Dow-Corning Corporation, Midland, Michigan, U.S.A., which was presented at the Rubber Technology Conference, held in London in June, 1948, under the auspices of the Institution of the Rubber Industry.

SILICONE rubber has undergone intensive development since its introduction and is now finding an increasing variety of uses which no other synthetic or natural rubber compounds have hitherto been able to serve satisfactorily. Applications arise principally from its unusual ability to resist heat, since it maintains resilience and flexibility at temperatures at least 200 degrees F. higher than the organic rubbers. Other notable properties are its retention of flexibility at very low temperatures, its good resistance to weathering, ozone and oils, and its excellence as an electrical insulating material.

The outstanding property of all silicone rubber compounds is their wide range of service temperature. They remain soft, flexible and resilient at temperatures from −75 degrees F. to 500 degrees F. This property is inherent in the silicone elastomer and is not achieved through plasticizers or special additives. After moulding and vulcanizing, only the vulcanized silicone gum and filler remain.

The product does not soften or melt at elevated temperatures and retains its vulcanized hardness with little change over a remarkably wide temperature range, from −70 degrees F. to over 400 degrees F. In tests on three separate stocks, brittle points were observed in all cases at −80 degrees F. The kind and amount of filler, however, has little influence on these brittle points, and the low temperature flexibility is inherent in the silicone elastomer. Flexing the samples or bending double at temperatures slightly above the brittle point did not damage the silicone rubber nor cause any change from the original elongation or tensile strength when returned to room temperature.

The tensile strength of silicone rubber is about one-third or one-fourth that of organic rubbers measured at room temperature. However, the product retains its mechanical properties on ageing in temperatures at which organic rubbers rapidly become useless. Test samples held in an oven at 300 degrees F., with a heat-resistant formulation of Neoprene (GR-M) used as a reference, showed that the organic rubber was a brittle solid after only one day, whereas the silicone rubber remained flexible after 90 days.

In addition to retaining its elastic properties when exposed to heat or cold, silicone rubbers are resistant to water, ultra-violet light and oxidation; these factors are the principal cause of deterioration of rubbers, or weathering. After 12 months' outdoor weathering, compared with the unweathered controls, the durometer hardness changed an average of 3 points, and the tensile-strength loss averaged only 14 per cent.

In another test, where moulded sheets of silicone rubber and organic rubber were bent double, fastened to test racks and weathered under similar condition, the organic rubber cracked badly while the silicone rubber remained sound. After one year of weathering the dielectric properties of silicone rubbers remain relatively unchanged; dielectric constants declined only slightly and power factor increased slightly.

Silicone rubbers that are compounded with appropriate low-loss fillers make excellent electrical insulation. A fairly wide choice of dielectric properties is possible by varying the filler. Ozone tests have brought out its high degree of resistance to ozone and corona. In recent tests conducted by an electrical

power distributor, a sample of silicone rubber satisfactorily endured a severe corona-resistance test for more than 4,000 hrs. without breakdown. Under identical conditions, the best organic rubber breaks down in from 50 to 150 hrs.

Silicone rubber also has high surface resistivity, which is maintained even under 100 per cent. humidity and moisture-condensing conditions, largely because water does not form a film on its surface. Since such rubbers are both heat-stable and water-repellent, they are finding applications in radio, radar and other electrical equipment.

Silicone rubbers swell slightly in most oils, but the least amount of swelling is found in low-aromatic-content oils. Most rubbers deteriorate with swelling, but silicone rubbers are only plasticized and improved in elongation by contact with hot oil. Above 175 degrees F. most rubbers deteriorate rapidly in oil. Silicone rubbers, however, are satisfactory from temperatures of 175 degrees F. to 400 degrees F. when exposed to hot oil.

Resistance to permanent deformation under heat and pressure are important when rubbers are used for gasket materials and seals. The best formulations of synthetic rubbers have fairly low compression set up to temperatures of 200 degrees F. From 200 degrees F. to 400 degrees F. only silicone rubbers have the necessary resistance to permanent deformation under heat and pressure. Silicone rubber thus has a useful temperature range 180 degrees to 200 degrees F. above organic rubbers commonly used for gasket materials.

Silicone rubber pastes are useful for coating inorganic fabrics, such as fibreglass, because the general properties of the silicone rubber complement the properties of the fabric. The silicone rubber protects the fabric from corrosion or wear, and the fabric gives added tensile strength. The pastes can be easily spread with doctor blades or by hand. For many coating applications they require no solvent dilution before coating.

The continuous coating of silicone rubber paste on fibreglass tape and cloth is an important process. The coating is applied to the fabric by doctoring, roller coating, spraying or dipping. The silicone rubber is doctored on the glass tape at the bottom of an electrically heated tower and is then vulcanized as it progresses up the tower. Vulcanization is found to be complete when the tape leaves the tower.

Laminates of silicone rubber and glass fabric form a useful material for gaskets and seals. The fibreglass gives added strength, and the silicone rubber gives the required resilience. In one method several layers of glass-cloth coated with silicone rubber paste are vulcanized in the heated press. A softer type of laminate can be made with sheeted silicone rubber stock and alternate layers of silicone rubber paste-coated glass-cloth. Moulding pressures of from 100 to 500 lb. per sq. in. are used for the lamination. If the press platens are at a temperature of 260 degrees F., vulcanizing will take about five minutes. The platens are cooled to 100 degrees F. before removing the laminate.

The newest silicone rubber compounds are heavy pastes intended for use as luting and sealing materials. These materials are used to fill voids and openings in electric motors, as sealing around electric lead wires, and for mechanical luting and sealing where heat-stable resilient seals are needed. Vulcanization takes about 10 minutes at 250 degrees F. and no further heating is necessary since a soft and flexible seal is usually desired.

Silicone rubber stocks for extruding may be processed in a rubber or plastic tuber or in a wire-covering extruder. The extruding head or die does not need heat since the extrusion temperature should be below 130 degrees F. As the extruded shape comes from the machine it must be handled carefully and dusted with talc. The material is then put in an autoclave or steam-pressure cabinet for 3 to 5 minutes, using steam at 25 to 75 lb. per sq. in.

The Story of Phenol

by H. W. GRAESSER-THOMAS

At the Plastics Institute lunch at the Dorchester Hotel, on October 8, Mr. H. W. Graesser-Thomas, the President of the Institute, presented for his address the subject of "Phenol," one of the most important raw materials we have in the plastics industry.

ACCORDING to authoritative works of reference, the presence of carbolic acid as a distillate of tar which could be separated, was recognized by Runge in 1834; it was then regarded as an impurity which had to be extracted in the distillation of benzol, and it was the late Lord Lister who first experimented with the separated product. The work of Lord Lister has received much proper recognition by both tongue and pen, and I need here only draw attention to the fact that after experimenting with Pasteur's heat sterilizations in relation to antiseptic surgery he published in 1867 the results of his work in a paper bearing the title, "On the Antiseptic Principle in the Practice of Surgery." Lister first used carbolic acid in its undiluted state, then in a diluted form, so depriving it of its caustic action, as the best agent available for purifying skin round a wound. The first known use for carbolic acid as a general disinfectant is at Carlisle, where the town authorities about this time were experimenting in the disinfection of sewage. So far as I can ascertain, these are the first recorded uses in the world of carbolic acid.

Carbolic acid was accepted and used increasingly as an antiseptic for many general purposes, and in 1870 approximately 100 tons, with a melting point of 30 degrees C., was produced and sold at about fifteen shillings a pound. A carbolic soap came on the market earning an immediate popularity in the early '70s, and also a carbolic tooth powder which enjoyed a wide sale. Purification and, literally, crystallization had set in and the melting point improved from then on.

For some years following Lister's discovery, the fumes of heated carbolic filling the operating theatre provided the sole antiseptic safeguard to both surgeon and patient, and such faith was there in the new discovery that surgeons scorned to wear either mask or gloves. For many years afterwards, this method of heating carbolic to give off fumes was used in the sick room of a patient suffering from an infectious disease.

My grandfather commenced to manufacture in 1867, and a letter heading, which may have been issued a few years later, described him as a manufacturer of carbolic acid, Aurine and picric acid. I think this would actually be in the early 70s because by that time carbolic acid was the raw material for Aurine and picric acid, both being accepted as dyes, though, with the production of aniline dyes, Aurine soon fell into disuse. Picric acid, for years thought to be a harmless yellow dye, was not recognized as an explosive until the full force of its power for such purposes was brought to light both literally and violently—disclosed by a disastrous catastrophe. Lyddite—picric—thus became a standard high explosive, and even in the Second World War had its special uses.

The outbreak of the Franco-German War gave momentum to manufacture, and by 1890 the world production of carbolic was at a conservative estimate 1,000 tons a year, and may have been considerably more. Although Germany did not become a competitor for world markets until some years later, manufacture was being carried on there as a raw material, principally for dyestuffs, in 1888. No figures are available as to the actual German production for those first years prior to 1900, but at least it can

be stated with certainty that for 20 or perhaps even more years following Lister's discovery, all phenol was of British manufacture. In the late eighties, Germany was experimenting with the production of synthetic phenol; France followed soon afterwards. It has been recorded that a synthetic plant was in operation in France in 1894 for the sole purpose of producing phenol as a raw material for the manufacture of sodium salicylate. There was no production from tar in France at that time, nor for some years afterwards, and we learn further that another and much larger synthetic plant went into production—to be precise—on the 1st of March, 1900. The manufacture of phenol from coal tar in Germany was also very limited up to 1900, from which date tar production leapt up with a consequent increase in the output of natural phenol.

Information regarding early American production leads to the conclusion that, though manufacture commenced at the very beginning of the present century, it was not until 1915 that output by typical American standards was established. Then a large plant, undoubtedly for synthetic, came into being. Evidence of the insufficiency of home production there is provided by the fact that the synthetic resin known as "Bakelite," which had been discovered by the late Dr. Baekeland, years earlier, was dependent to some extent on importations of British phenol until 1914 and indeed perhaps even later. About the year 1917, when America took up arms against Germany, production surged forward. New plants were sponsored by their Government for war requirements, others erected by consumers for their own increasing and newly developing internal requirements.

Carbolic acid or phenol is a primary raw material for that group of fine chemicals, the salicylates, and by 1915 the First World War had cut off Germany—then almost the universal provider of salicylates—from the rest of the world. This milestone therefore marks the full entry of the United States into the fine chemical field, and indeed it might be suggested that this is when the fine chemical industry of America, later to become so vast, was actually and truly founded; because from increasing supplies of home-produced phenol and until 1917 a neutral country, she took over the mantle of Germany and became almost overnight the fountain of supply of the whole range of salicylates and other pharmaceuticals, the starting point for so many—then developing—new manufactures, and with such a multitude of diverse uses.

Although during the first few years of the present century, Great Britain produced half the world's output of phenol, Continental production was making rapid headway. I have no reliable figures of German output over the years 1900 to 1910, but the available statistics relating to coke oven and gas-works tar, from which phenol is distilled, provide interesting data and give a guide. We know, for instance, that in 1900, the German production of coke oven tar was only 163,000 tons, but by 1910 had increased to 823,000 tons; in addition to this there is gas works tar, which was 180,000 tons in 1900 and 350,000 tons in 1910.

Now what of phenol in relation to plastics? It has been authentically recorded that in this country research into the phenol-formaldehyde reactions commenced in 1904. Little did the makers of phenol—and I venture to say even the early pioneers of plastics—realize how important they were subsequently to become to each other and in relatively how brief a space of time. The close link between phenol and plastics was not really forged until some years later.

The word phenol was not for many years generally and commercially used, indeed I think I may say that the plastics industry has largely popularized it. Manufacturers, until fairly recently, described the product on their sale notes and invoices as carbolic acid crystals, and the wholesale druggists and pharmacists have their own terms used in prescribing pure carbolic according to the British Pharmacopœia, such as Acidum Car-

bolicum Cryst. and Acid Carbolicum Liquefactum. Another quality of carbolic was, and still is, manufactured specially for medical purposes, being described as "Detached Crystals" or "Absolute Phenol."

Whilst I do not propose to dive into the deep waters of technical exactitudes, indeed I am not qualified to do so, it might be as well to say something further in regard to this word phenol. The description phenols applies, in fact, properly to several distillates from coal. Phenols of the naphthalene series are described as naphthols, and those from toluene as cresols.

Cresylic acid was, commercially, an unknown term prior to the First World War—if not later—and the whole range of liquid cresols and xylenols, with their normal impurities, were covered by the generic description liquid carbolic. In a world in which distillates of coal tar were finding increasing applications for many new purposes, buyers became more discriminating and although it was not then expected that the maker could or would control or describe impurities within narrow limits, the general extent of impurities would be stated. It is interesting for present-day consumers, particularly in the plastics industry, requiring percentages of pyridine and naphthalene to be eliminated or perhaps retained to a tenth of 1 per cent., to recall that up to the time of the First World War the various qualities of liquid carbolic (or as we now know it, cresylic acid) would be designated something as follows:—Straw coloured 95/97 per cent., double distilled 97/98 per cent., or, very rarely obtainable, water-white 98 per cent. The percentage indicates the tar acid content.

Although British manufacturers had up to 1914 a substantial market in this country for the antiseptic and medicinal uses of phenol, and also to help feed the growing dyestuff industry, they had still to rely on a considerable export demand, principally from countries which had not commenced manufacture, and probably most of all from Japan.

With the outbreak of the First World War in 1914, phenol became a vital raw material as the starting point for picric acid or lyddite; it followed naturally that the Government at once took steps to increase output and control the supply of crudes to the refiners. A simple, efficient and entirely satisfactory form of control was established: a well-known firm of city chartered accountants was appointed, with a senior partner as chairman of a committee of manufacturers. Two basic prices were fixed, one shilling and threepence per pound for supplies for picric manufacture and one shilling and sixpence per pound for other uses. The price of crude carbolic was also controlled and diverted to the various refining works—there were only three or four—allocated according to the refining capacity of each individual user. Most of the phenol produced throughout the years 1914-18 went for picric. At least one phenol manufacturer also made the explosive, though the nitration process was carried out at a separate site. Much also was required for medicinal purposes so that phenol was produced both to kill and to cure. Supplies of natural phenol were insufficient to meet the demands of war and by 1915 the first British synthetic plant was in course of erection, but at the end of the First World War fell into disuse and was never worked again, though some years later synthetic manufacture on a large scale was undertaken on the same site. An important synthetic plant was also erected in Northwich about the same time and the closest and most friendly contact was established between that plant and the one at Ruabon throughout the war years. I well recollect the friendly rivalry and competition in comparing and improving yield as between one works and the other and also the free exchange of information to the common advancement of synthetic manufacture in those early days. The Northwich plant also ceased production after the war. France also produced huge quantities of synthetic during 1914-1918 and—of course—America.

(To be continued)

Estimation of Chlorine in Polymeric Materials

By W. M. Phillips

THE increasing availability of micro- and semi-micro apparatus has facilitated the introduction of small-scale analytical methods, some of which are very useful even in the absence of a micro-balance. In the estimation of chlorine in organic compounds by the method to be described, the points in favour of the micro-scale are well illustrated, in that the apparatus used is simple and easy to manipulate, while the time of experiment is comparatively short and the determination is finished conveniently by titration. By contrast, both the Carius and Parr bomb methods involve special apparatus, and results by the Carius method, used on a macro-scale, may not be available in less than a day and a half, although the working time is considerably shorter than this. The method here described takes 2½-3 hrs. for all stages of a single estimation. It has been used for finding the percentage of chlorine in polychloroprene rubbers (raw or vulcanized), polyvinyl chloride, and a copolymer containing polyvinylidene chloride.

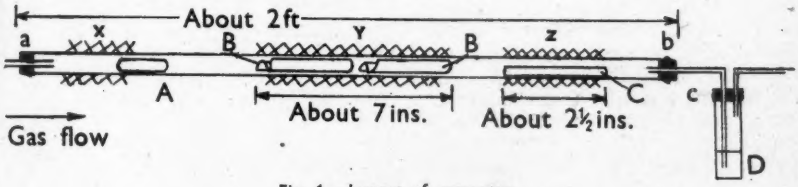


Fig. 1.—Layout of apparatus.

Apparatus

The apparatus, represented diagrammatically in Fig. 1, is based on that described by Belcher and Godbert, "Semi-micro Quantitative Analysis," London, 1945. The combustion tube is of hard glass, about 2 ft. in length and ⅜ in. internal diameter, and is covered, in the positions where it is to be heated, with rolls of wire gauze, x, y, and z. Oxygen from a cylinder of the compressed gas is passed into the tube at a, the flow being regulated by a Pregl-type pressure-regulator and bubble counter. The exit gas passes through silver nitrate solution D in a guard bubbler. The sample is contained in a platinum combustion boat A, placed a short distance from platinum Z-section contacts at B, which are heated by a long burner. A long porcelain boat C, containing barium carbonate, is placed 3-4 cm. from the contacts and is heated by a bunsen burner. Rubber bungs are used for the connections at a, b, and c.

Method

The combustion tube, cleaned by soaking in chromic acid, is rinsed with water, then with alcohol, and dried by suction at the pump. It is supported at each end by a retort stand, the wire gauze rolls are placed in position and the platinum contacts inserted after they have been re-etched if necessary (vide infra) in dilute warm aqua regia, but in any case after they have been boiled in dilute nitric acid, rinsed and ignited.

The porcelain boat, C, conveniently 7 cm. by 0.6 cm. outside measurement,

treated in the same way as the platinum ware, is filled level with halogen-free barium carbonate and introduced into the combustion tube through the open end b. Oxygen is passed through the tube at the rate of 11-12 ml. per min. and escapes through the guard bubbler. The tube is heated to about 600 degrees C. at the positions of the catalyst and absorbant (y and z). Meanwhile, the sample (about 20 mg., depending on chlorine content) is weighed out into the combustion boat, which is then introduced into the combustion tube, pushed to about 4 cm. from the platinum contacts and heated gently, so that the sample burns off during about 1 hr.

When the sample is completely burnt, heating is reduced and finally discontinued, and the tube is allowed to cool whilst oxygen is still passed through. The boat containing barium carbonate is withdrawn, the contents suspended in water in a porcelain dish, and titration of the dissolved barium chloride carried out with 0.025 N silver nitrate solution in the presence of a few ml. of starch solution and dichlorofluorescein indicator. If the acidified silver nitrate solution (D) in the guard bubbler becomes turbid, showing that hydrochloric acid formed has not been completely absorbed, the combustion is abandoned.

The first experiments using this method gave low values compared with those expected, and various factors likely to affect the results had to be investigated. It was found that by using a platinized asbestos filling as the catalyst, higher values were obtained, showing that the catalytic decomposition of the combusting material was incomplete and that a larger surface area of platinum was necessary. In view of the possible absorption of gases by platinized asbestos, the increase of area was achieved by re-etching the platinum contacts in warm dilute aqua regia, and after this, values were obtained in closer agreement with the theoretical.

For acetone-extracted raw Neoprene GN (polychloroprene), where the calculated percentage of chlorine was 40.1, the figures obtained were originally 37.2 per cent., using platinized asbestos 38.7 per cent., and with re-etched contacts 40.3 per cent.

It was desired to have as a reference compound, a chlorine-containing organic substance obtainable in a pure state. o-Chloro benzoic acid, when analysed as supplied, gave 22.01 per cent. chlorine as compared with 22.65 per cent. calculated, but after recrystallization, the mean percentage chlorine present was 22.70.

Determination of Chlorine in Polymers

Estimations of the amount of chlorine present were carried out on Neoprene GN in the raw and vulcanized states, on powdered polyvinyl chloride, and on a copolymer of vinyl and vinylidene chlorides. In each case, the expected amount of chlorine present could be calculated.

For confirmation, the Carius method of estimating chlorine was applied to the p.v.c. and copolymer. Acetone-extracted raw Neoprene GN was taken to be pure polychloroprene after allowance had been

TABLE 1.

Substance.	Wt. of Sample.	Balance used.	Results, per cent. chlorine.			
			Individual.	Mean	Theoretical.	Carius.
Raw Neoprene GN. ..	20 mg.	micro.	40.34, 40.33	40.34	40.05	—
Neoprene GN vulcanisate	20 mg.	micro.	34.45, 34.35	34.40	35.9	—
Polyvinyl chloride powder	20 mg.	aperiodic	55.98, 55.65, 55.61, 55.63	55.64	56.73	55.9
Vinyl chloride - vinylidene chloride co-polymer ..	15 mg.	aperiodic	65.42, 65.30, 65.71, 66.12	65.64	64.93	65.3

made for its ash. The percentage of chlorine in a "pure gum" Neoprene vulcanisate, i.e., one not containing any filler, was calculated from the mixing formula, allowing 38 per cent. chlorine in the crude Neoprene. So far as was known, the powdered p.v.c. consisted of polymer alone, and the chlorine content of the copolymer was calculated on the basis of its being 50:50 vinyl and and vinylidene chlorides. In the original experiments, the sample was weighed on a micro-balance; subsequently, an aperiodic balance was used.

Since the Neoprene GN vulcanisate contained magnesium and zinc oxides, some chlorine will have been held back in the ash combined with these elements. This accounts for the fact that the result was lower than the expected calculated value. Normally an extract of the ash should be made and the chloride obtained in solution included in the titration.

Discussion

The semi-micro method described has been shown to give reproducible results in agreement with the calculated percentage of chlorine on a pure organic compound, and results comparable with those obtained by the Carius method on polyvinyl chloride and on the copolymer. A more rapid combustion method is described in A.S.T.M. Standards on Rubber Products (1946 edition), but the use of a faster gas stream makes several absorption vessels necessary, while a special furnace is required in order to carry out combustion at a higher temperature.

The apparatus here described can be assembled in any laboratory, and duplication to enable parallel estimations to be carried out is obviously practicable. A micro-balance was originally used whilst awaiting the delivery of the ordinary aperiodic balance; the latter is sufficiently sensitive for the purpose, and, of course, more quickly operated.

The author's thanks are due to the Research Association of British Rubber Manufacturers for permission to publish this paper.

"Open day" was held on October 23, at the works of T. H. and J. Daniels, Ltd., Stroud. Some 500 guests attended the lunch and then visited the shops, where a multitudinous array of heavy and light precision machinery, including a wide variety of the well known plastic presses made by this concern, were on view. The photograph on the left shows the assembly section and heavy erection shop, with an hydraulic press on test; that on the right shows Mr. J. L. Daniels, his daughter, and a group of visitors watching the actual operating of a 10D injection moulding machine.

LETTERS TO THE EDITOR

Correspondents are reminded that a stamped and addressed envelope should be enclosed in all cases where a personal answer is desired. It is understood that any letter received may be published at the discretion of the Editor.

Large Injection Machines

Sir,—We have read the editorial in your October issue on the subject of large injection mouldings with particular interest, since we ourselves have running in our injection shop a 40-oz. capacity H.P.M. injection machine which we believe to be the largest in this country and certainly one of the largest machines in regular operation in the world.

We are in agreement with your statement that these big machines are much more suitable for the production of larger and heavier mouldings rather than a multiplicity of small parts for both technical and economic reasons.

One of our present productions on this machine is a large bowl weighing nearly 2 lb., moulded from polythene, of which we enclose a photograph for your interest. This bowl has already found many uses,

ranging from washing dishes or the baby, to special process work in the chemical industry.

We believe ourselves to be amongst the pioneers of this large injection technique in this country, and it is our firm belief that as designers of motorcars, radios, building components, etc., begin to appreciate the possibilities which these large mouldings offer to them, then the 40-oz. machine will be quite usual.

As to whether even larger machines will be in operation in the future depends probably less on the machine designers and moulders than it does on the material suppliers, and it may be that one day will see the use of injection machines for large mouldings made from new materials with improved flow and physical properties.

In the meantime, if any industrial designers have problems in which our experience of these large machines can be of assistance, we shall be only too pleased to hear from them.

Hale End, HALEX, LTD.
London, E.4.

Beryllium-copper Moulds

Sir,—I have noted in your October issue the statement, in reply to a correspondent's inquiry, that the only concern in this country who regularly make beryllium-copper is Mallory Metallurgical Products, Ltd.

I should like to correct this statement, as my company has been engaged in the manufacture of such alloys for many years. The matter raised by your correspondent has been a subject of particular study by us and we have actually taken out a patent on this application, No. 606,402.

For your information, I enclose our literature on beryllium-copper.

W. F. RANDALL, Director,
Telegraph Construction and Maintenance Co., Ltd.
London, S.E.10.

Sir,—With reference to the letter from Silcoms, published in your October issue, on the question of beryllium-copper moulds, you might be interested to learn that we roll beryllium-copper, and have already made a mould for the injection moulding of thermoplastics. It is at

present being tested on a production run and, so far, appears to be quite satisfactory.

EVERED AND CO., LTD.
Surrey Works,
Smethwick, Staffs.

Quality Control

Sir,—We have read with interest the articles on Quality Control, by Mr. Halliday, which you have published month by month and in which he deals in admirable detail with the day-to-day inspection of plastic mouldings.

We have noticed, however, that he has not yet mentioned the British Standard 1313—"Fraction-defective charts for quality control," which should be of use to those trying out quality control methods after reading his articles. It may be that Mr. Halliday has not yet had an opportunity to read this British Standard. We, therefore, enclose a copy and would be glad if you would kindly pass it to him.

BRITISH STANDARDS INSTITUTION.
London, S.W.1.

[EDITOR'S NOTE: Although our contributor has not yet referred to B.S. 1313 an editorial concerning the same was published in "Plastics," December, 1947 (page 624).]

Phosphorescent Plastics

Sir,—We received a few months ago, from one of our suppliers, a sample of phosphorescent moulded cellulose acetate. When that material was brought into darkness, its phosphorescent power quickly decreased and completely disappeared after about half an hour.

Such material could find very interesting uses in our line, especially for watch and all kinds of dials, electric switches, etc., if only the luminous power could last longer, say, 12 hours at least.

To try to find an improved material, we wrote to several firms whose addresses were found in "Plastics" magazine, with negative results. One concern even wrote us that within their experience, no company has yet been able to manufacture an injection moulding powder capable of remaining luminous after four hours.

Because of the importance of the problem, we tried something in our own laboratory and managed to manufacture a material which, from point of view of durability of luminous power is absolutely perfect. Indeed, it remains shining for a time long enough to be successfully used for the above-mentioned purposes. We have already applied for Swiss and foreign patents.

But in this matter a few more questions have to find an answer, principally the problem of coloration of the material.

Could you, please, help us to find, in England, a firm whose technical staff would agree to carry on that phosphorescent material business in co-operation with us.

TONY VAURILLON S.A.
Geneva, Switzerland.

Packaging Film

Sir,—We have a letter from an Australian customer asking whether there is an English equivalent of an American product known as "Plastofol." This we understand to be a transparent flexible plastic suitable for making packages which are collapsible. It is made of laminated layers of vinyl chloride and acetate. If you could suggest any makers of similar or alternative products, the information would be appreciated.

W. A. SPARROW AND CO., LTD.
London, E.C.2.

[EDITOR'S NOTE: It is not clear from the above whether our correspondent refers only to the vinyl type, since cellulose acetate film is also flexible, and, indeed, widely used for packaging purposes. Makers of cellulose acetate film include British Celanese, Ltd., Hanover Square, London, W.1; Utilex, Ltd., Mill Street, Kingston-on-Thames, Surrey; B.X. Plastics, Ltd., Higham Station Avenue, London, E.4; M. and B. Plastics, Ltd., 3, Wimpole Street, London, W.1. The more recent other types are polythene film, made by I.C.I., Ltd., Plastics Division, Welwyn Garden City, Herts; "Vybak" film, by Bakelite, Ltd., 18, Grosvenor Gardens, London, S.W.1; and "Geon" film, by British Geon, Ltd., 21, St. James's Square, London, S.W.1.]

PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes

TUNGSTEN CARBIDE TOOLS. — Methods used in the application of high-speed tools are not suitable with tungsten carbide; in order to get the best from this hard metal, closer consideration than is usual with high-speed steel must be given to the design of cutting tools. A film showing the correct methods of choosing the style and grade of Wimet tools for various operations, and the manner in which the recommended shapes, sizes and rakes, should be exploited to obtain full benefit from their use has therefore been made by A. C. Wickman, Ltd., Coventry. This film will improve the general understanding of the new technique required to obtain the best results from using tools tipped with tungsten carbide. Copies of the film will shortly be available for showing in engineering works, technical colleges, etc., throughout the country.

ACQUAPLAS.—The Acqua Shell and Associated Industries, Ltd., of Preston, Brighton, have introduced a small sealing machine for joining plastics to metal. It is useful to the jewellery and fancy goods trade. The metal portion is electrically heated before pressing upon the plastic.

EXHIBITION TRAIN.—The Allied Ironfounders exhibition train displaying heating appliances and allied products and now visiting London and provincial centres, is panelled in "Formica" (the laminated sheeting made by De La Rue Insulations, Ltd.).

TRADE WITH JAPAN.—A paper on the future development of the Japanese economy and the opportunities for British trade with Japan has been written by H. A. Macrae, formerly Minister (Commercial) at H.M. Embassy, Tokyo. This paper has been published by H.M. Stationery Office, price ninepence.

PROFESSOR JAMES KENDAL, M.A., D.Sc., F.R.S., will deliver the Second Baekeland Memorial Lecture at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, at 5.30 p.m. on November 16, 1948. The title of the lecture will be "Leo Hendrik Baekeland and the Development of Phenolic Resins."

BEETLE PRODUCTS, CO., LTD.—We have received six technical leaflets from this concern. Five of them, MP1 to MP5, refer to the physical properties and moulding conditions for: Melamine Q grade, Beetle X/T grade, Beetle X/D grade, Scarab grade and Beetle Melamine K.592 grade moulding powders, respectively. The sixth leaflet describes the use of Beetle cements for bonding wood waste, etc., in the manufacture of building boards, floor blocks, etc.

SUFLEX, LTD., have opened their new 15,000 ft. plastic products factory on a five-acre site at Risca, near Newport, Monmouthshire where they have greater manufacturing facilities and more room for further development than at the Maida Vale works. At the same time, the registered offices have been transferred to 35, Baker Street, London, W.1. Telephone: Welbeck 8323.

CELANESE CORPORATION, U.S.A., announce Lumarith XF for use in electrical housings, display goods, etc. The plastic is described as a fast moulding, flame- and heat-resistant thermoplastic.

DE LA RUE INSULATION, LTD., announce that Mr. S. P. Jordan, A.R.I.B.A., M.S.I.A., head of the Design Section, has resigned to take up private practice as architect and design consultant. Mr. Jordan, however, will be retained as design consultant by De La Rue and will maintain his connection with the company's "Formica" and other laminated plastics. Mr. Jordan joined De La Rue as head of their new Design Section shortly after the war. He initiated much of the research and development work on adhesives and methods of fabrication.

T. J. SMITH AND NEPHEW, LTD., makers of Elastoplast have appointed Miss Vera Seymour, 6, New Court, Lincolns Inn, London W.C.2, to undertake the post of press liaison officer.

JILLAND CO., LTD.—This company has been appointed by Turner and Newall, Ltd. (manufacturers of "Durestos" phenolic-asbestos sheeting), to represent them in an editorial capacity.

ANDREW FRASER AND CO., LTD., manufacturers of Fraser mono-radial hydraulic pumps and control valves, have

acquired new premises at 29, Buckingham Gate, London, S.W.1. Telephone: Victoria 6736/9.

F. H. TOWLER, M.I.Mech.E., has been invited by the American Society of Mechanical Engineers to deliver a paper on "The Parallel Development of Heavy Self-contained Hydraulic Presses in U.S.A. and Great Britain" at the annual meeting of the Society in New York on November 29, 1948.

Mr. F. H. Towler is chairman of the Hydraulic Association of Great Britain and an authority on the application of the direct system of operation to hydraulic machinery. He is a director of Towler Brothers (Patents), Ltd., of Rodley, Leeds, England, and of Electraulic Presses, Ltd.

Other official positions held by Mr. Towler are member of the Council of the British Engineers Association, of the Council of the British Plastics Federation and a member of the Hydraulic Machinery Committee of the D.S.I.R.

MR. HAROLD ROSE, B.Sc., 7, Stone Buildings, Lincoln's Inn, London, W.C.2, has now resigned his post with Uni-Seco, Ltd., and has set up in practice as an independent consultant.

E. S. WADDINGTON, of Philips Electrical, Ltd. (Industrial Department), has been elected vice-chairman of the Beama Resistance Welding Machine Section.

NOTES FROM THE BRITISH PLASTICS FEDERATION

New Members

MOULDERS' GROUP: The Commercial Ignition Co., Ltd.

ASSOCIATE MEMBERS: Intrama, Ltd.

Horners' Prize Awards

Eleven entries were received this year for the prizes provided by the Worshipful Company of Horners for the encouragement of young craftsmen within the plastics industry. The entries were of a high standard, particularly those for the general arrangement of a moulding tool. As a result of expert adjudication the Council decided to award three prizes, as follows:—

Design for a Moulding: A prize of £10 to Mr. L. Picken, of Fox and Offord, Ltd., for his entry "a moulding arrangement of a pocket chess set."

Drawing for the General Arrangement of a Moulding Tool: A prize of £15 to Mr. W. H. Westwood, of Fox and Offord, Ltd., for his entry "a mould for a stormrail bracket," and a further prize of £15 to Mr. F. Seed, of United Ebonite and Lorival, Ltd., for his entry "an eight-impression tool to produce a 15 amp. fuse base carrier."

Imports of Moulding Powder

Imports of moulding powder during August and September were as follows:—

	Aug. tons	Sept. tons
Phenol-formaldehyde ...	17	—
Urea-formaldehyde ...	37	11
Cellulose acetate butyrate	19	9
Polystyrene	93	107

British Industries Fair, 1949

In spite of strong representations by the Federation and protracted negotiations with the Export Promotion Department, Board of Trade, the expected move of the Plastics Section to Olympia has not proved possible this year. The Section will, therefore, again be at Earls Court, on the first floor. The total amount of space applied for is 22,403 sq. ft., the total amount allotted to the section is 20,776 sq. ft. The number of applications for space is approximately 50.

Visit to America

A deputation of nine members of the Moulders Group, headed by the Chairman of the Group, Mr. L. McArd, of Robert McArd and Co., Ltd., has visited America. The party comprised Messrs. W. Chas. Waghorne (Insulators, Ltd.), L. Cornelius (Derwent Plastics, Ltd.), J. E. Elliott (E. Elliott, Ltd.), F. E. Wall (Healey Mouldings, Ltd.), F. M. Herzberg (Hornflowa, Ltd.), H. G. Humphreys (Ranton and Co., Ltd.), F. A. Garrett (Rootes Mouldings, Ltd.), J. Johnston (Universal Plastics, Ltd.), and the General Manager (Dr. W. E. de B. Diamond), who officially represented the Federation at the Third National Plastics Exposition, which was held in New York from September 27 to October 1.

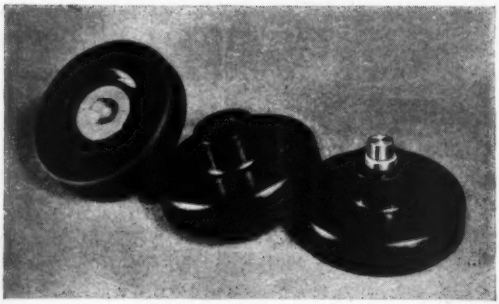
Through the courtesy of the Society of Plastics Industry of New York, arrangements were made for the party to visit the Boonton Moulding Co., New Jersey; the moulding department of the Remington Rand organization at Bridgeport, Conn., and the Monsanto plant at Springfield, Mass.

At the Exposition, the outstanding feature which impressed all the members of the deputation was the great advantage the American moulders and fabricators have in variety of materials available.

OVERSEAS INQUIRY

We have received information that the Internacional Exporta dora Lda., Apertado No. 544, Rua A, as Amoreiras, 4, 1.-Esq., Lisbon, Portugal, wish to obtain supplies of plastic covering materials, etc.

New Productions from the Moulding Shops



Key Button

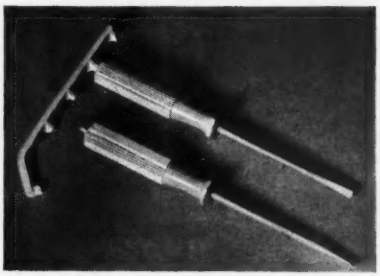
The outstanding feature of this key button is that the lettering is almost indestructible. It has been designed for use on typewriters, type-setting machines, calculating machines, lift-operating panels, etc., and is the subject of a patent application. The lettering is either engraved or moulded on the underside of a transparent insert which is secure in a circular recess in the opaque, coloured body of the button. The material employed is polystyrene, which, apart from being transparent where so needed, is also impervious to moisture and resistant to scratching and abrasion from continuous touch of the finger. Any lettering or numbering remains clearly visible and permanent. The injection moulding process employed allows for interchange of characters, this taking place within a master die. The makers are E.V.B. Plastics, Ltd., Pear Tree Hill, Brighton Road, Salfords, Surrey.

Roller Bearings

The noiseless and smooth running of the drawers of the stainless-steel sink units, kitchen cabinets and other metal furniture made by Vernons Industries, Ltd., of Liverpool, is attributed to the use of plastic roller bearings. A group of these roller bearings, 1⅜-in. diameter by 1¼-in.-wide face, with the steel spindle inserted after moulding, is seen in one of the illustrations on this page. The mouldings, in phenolic, are made by Moulded Products, Ltd., Erdington, Birmingham.

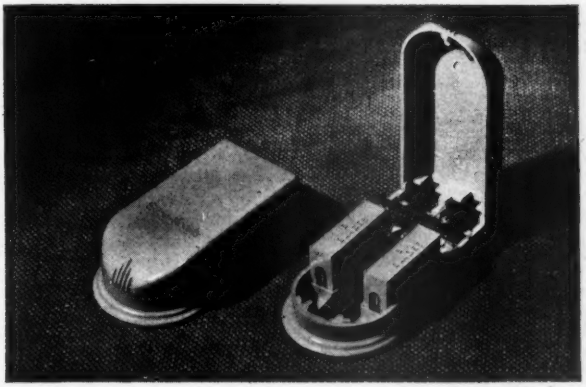
Racquet Strings

Racquet strings made from nylon monofilament are now being produced in this country for the first time. These strings are suitable for tennis, badminton, and other types of racquets, and are available in single sets or bulk coils sufficient to string 30 racquets. Experience with nylon strung racquets has been very satisfactory, and sportsmen in this country will find the new nylon strings serviceable and hard-wearing under all conditions of play or storage. The outstanding ability of nylon monofilament to withstand dampness and its freedom from fraying or splitting ensure a long life for nylon-strung racquets when used on hard or grass courts.



Electrician's Screwdriver

The handles of these electrician's screwdrivers are of cellulose acetate, and are claimed to give adequate insulation against currents up to 5,000 volts. As seen in the illustration they are injection moulded, with the steel screwdriver blades as inserts; the moulders are Fraser and Glass, Ltd., Woodside Lane, Finchley, N.12.



New Ever-Ready Pack

The new plastic-moulded razor pack for Ever-Ready possesses clean, pleasantly rounded contours, devoid of superfluous decoration, a snap-shut lid which stays shut and a neat arrangement of the interior; all reflect the precision and efficiency of the shaving instrument itself.

The pack is moulded in materials from the Beetle range of moulding powders, by Illingworths (Plastics), Ltd., specialists in package moulding. The design is by Mr. I. E. White, of that company.

Perhaps the most interesting feature of the container is its snap-shut, pinless hinge, also of Mr. White's design and provisionally patented by E. Illingworth and Co., Ltd. The hinge is self-locking, and once shut the lid remains firmly closed. This secure closure eliminates the necessity of a front catch and is effected by the two leaves of the patented hinge, made from annealed spring steel, hardened and plated. A further and important advantage is that the hinge is simply pressed by hand into moulded recesses in the container and lid, where it is held fast by spring lugs; this eliminates any supplementary drilling operations and greatly facilitates assembly.

On the inner front of the lid are two locations for holding in position two different sizes of razor. Two small projecting lugs on the front lip of the container are provided to prevent any lateral movement of the lid when closed. Three-point contact on table or shelf ensures the absence of any rocking tendency. The sides of the blade sheaths are tapered in section to give sufficient flexibility for a sure, firm friction fit in the cavities moulded in the container. All these points illustrate the great care and practical consideration which have been given to the detail planning of this outstanding razor pack design.

If its design is refreshingly unconventional, no less are the self-colours in which the packs are moulded—grey, walnut, blue, red and natural, to brighten up the bathroom shelf.

Automatic Scales

The scoop, body, and base of these scales are all moulded in urea-formaldehyde material for George Salter and Co., Ltd. The Streetly Manufacturing Co., Ltd., were the moulders.

Quality Control in Plastic Moulding—XII

By W. M. HALLIDAY

This present section treats of a number of interesting and valuable refinements which may be made in standard quality control procedures introduced in the inspection of moulded components.

These modifications relate chiefly to the various useful forms of sampling and gauging in cases where wide dimensional or other tolerances are permitted. They illustrate how quality control methods may be simply adapted so as to secure greater economies in inspection times hitherto bestowed on the job, or to suit specific requirements desired in the plastic moulded article under production.

AS readers will doubtless have already understood, from the previous discussions upon general technique and applications of quality control methods to the manufacture of plastic mouldings, and especially those of the fraction defective type latterly fully considered in this series, one of the chief advantageous features possessed is that of their great flexibilty of application.

This flexibility of quality control principles and methods, both in regard to their manifold applications, and the ease with which they may be readily adapted to suit peculiar or unusual needs arising in any production problem, often affords the greatest benefit to the production moulder charged with the effective control of accuracy or quality of the finished articles.

However, it certainly deserves restressing at this point that quality control procedure does not constitute a strict set of rigid rules which are more or less inflexible in their application, and to suit which the job in hand and all its associated production problems or features must be modified, altered or transformed.

On the contrary it very often happens that some seemingly insuperable production difficulties or inspection problems become capable of economical solution by the mere adaptation of the quality control inspection methods already in use, or, if it is a new production job, by introducing a slightly amended form of control procedure. In the present article, therefore, the author proposes to direct attention to a number of interesting ways in which ordinary standard control procedures can be modified the better to meet the needs of some unusual inspection problem, or to effect worth-while savings of time and labour hitherto required in conventional inspection practice applied to the subject.

Controlling Production when Wide Limits of Variation are Allowed

The first point to be dealt with refers to the inspection needs involved in the production of moulded articles which possess very ample dimensional tolerances or wide latitude in respect of their other physical features. The plastic moulder is very often charged with the manufacture of articles where considerable freedom is permitted in respect of every aspect of the component with, say, the exception of its surface finish. This latter factor is, of course, largely determined by the quality of the surface finish imparted to the mould cavity, a factor which often is quite easy to maintain under control.

Such plastics components are legion to-day, being widely employed in those applications where pleasing line and appearance are the vital requirements; numerous instances are to be found in toys, purely decorative objects, domestic appliances and utensils, etc.

In the actual production of such moulded parts as these, however, their

systematic inspection by standard quality control methods, as fully described earlier in this series, may prove most unsuitable on the grounds that a completely disproportionate amount of inspection effort and connected clerical work may be involved in maintaining such control. Obviously, where it is not necessary to indulge in careful gauging or measuring on dimensions, etc., much needless effort may be incurred if ordinary quality control methods are introduced.

On the other hand, conventional non-quality control types of inspection may prove equally unreliable, and costly in the long run, by failing to ensure an adequate amount of check over production as it proceeds day by day. In order, therefore, the more fully to realize the various ways in which troubles may arise when using customary inspection methods for such a product, it will help if a brief sketch is given now of the kind of activity which usually takes place.

Customary Inspection on Work of Wide Tolerance

Preliminary to commencing production at all, the mould will probably be sent to the toolroom for overhaul and readjustment where necessary. In the case of a mould which has had previous production service, this would comprise re-polishing of the cavity walls, re-setting of the ejectors, securing of the cores, or taking the play out of core slides and connected mechanism. The bolsters would most probably be tested for sealage at the various parting-lines, whilst any wear occurring within the mechanism of the mould would be corrected.

These operations would be carried out before the tool was issued for production in the hope that the entire ensuing production run would then be accomplished without serious mishap or trouble in so far as the mould was concerned. Except in the case of a serious breakdown, or too obvious a fault exhibited on the mouldings, no further attention would be given to the tool. This is in marked contrast, by the way, to the treatment required when using a moulding tool for the manufacture of precision mouldings, when every incipient fault or error observed would have to be immediately investigated by examination of the mould with the necessary adjustments or correction as demanded.

After tuning-up the mould in the aforesaid manner, it would also be assumed that the tool was of such a quality as to render unnecessary frequent or stringent inspection of the products issuing from the mould.

With the finished mouldings, cursory and sporadic inspections or checks would be made during each production run. Often such inspections would largely consist of a visual examination by some experienced person or one familiar with the quality of the articles previously produced from the mould and which were accepted by the customer. Only occasional gauging of dimensions would be performed. Therefore it may be said that no detailed, regular and systematic inspection would be carried out, a great deal of reliance being placed upon the judgment and degree of observation of mould operator and setter.

Large quantities of mouldings are, in fact, produced under these or similarly unorganized inspection facilities, and, of course, the results are not always satisfactory for the client receiving the parts and the moulder supplying them. Moreover, it will be clear that under such inspection conditions, large numbers of defective or even downright uncorrectable components may get by to suffer ultimate rejection by the user, with all the resultant irritation and expense for both sides concerned in the matter.

In order to deal adequately with the requirements of what may be termed non-precision types of plastics mouldings, the production moulder must have available some simple yet flexible system of inspection which will afford him a high degree of assurance that large percentages of faulty or defective or

scrapped parts are not likely to be produced for any serious length of time without being detected before being dispatched to a customer.

At the same time he requires to be assured that the minimum amount of time and effort is being expended upon the purely inspection functions consonant with the tolerances permissible on the work, the volume of articles produced per given period, and the inspection facilities available in the moulding shop.

It is therefore essential that the scheme of inspection be simple, and inexpensive in operation, as the moulding job would most probably not bear anything like the amount of inspection charges normally entailed when producing precision-type articles controlled by standard quality control procedure.

Inspection Based Upon Compound Sampling

To meet the above set of circumstances it is possible to employ an adapted form of quality control based upon a compound or double system of taking samples in the manner now to be explained and illustrated.

Under this system of inspection it is preferable for the parts to be checked or gauged at some central and separate inspection department, instead of at the actual point of their production as with the forms of quality control already dealt with in earlier sections, the reason being that the products from the mould need not be inspected at very frequent intervals as in the case with ordinary quality control methods. The check provided is based not upon a 25 per cent. or 30 per cent. sample group taken hourly or bi-hourly during the production run, but upon a small percentage of a large bulk quantity, which is sampled in a double fashion, as will be explained.

At regular but relatively widely-spaced intervals large batches of moulded components would be taken to the central inspection department for sampling. The period between inspections will, of course, be dependent upon the conditions associated with the operation. Thus, in the case of a single impression tool, sampling may be performed only once per two days of production, as the quantity of components accumulating during this time may be small. On the other hand, with, say, a 40-impression tool, the sampling may have to be carried out once or twice per day in order to maintain the handling of the parts, when reaching the inspection department, at the most convenient level.

Moreover, the wider the tolerances permitted on the products, the less frequently need sampling be undertaken. This point will be dealt with later, when other factors affecting the decision will be considered in detail.

The Overall General Quality

As a preliminary to the institution of this inspection system, the production moulder should make an estimate of the overall general level of quality or accuracy permissible with the particular class of work being dealt with. This estimation would be based upon a number of easily ascertainable factors, the chief of which would be the following:—

(1) The percentages of faulty, defective and scrap components to correct ones produced at previous production runs. This data would, of course, be derived from actual records of preceding moulding operations from the mould. In the case of a brand new mould, a trial run would have to be taken in order to elicit the above information, since a theoretical estimate would not be sufficiently reliable.

(2) The incidence or rate of occurrence of defective work during a production run. It will be appreciated that in making this estimate it is not sufficient merely to ascertain how much defective work is normally associated with a production run of the usual kind, but in what manner and at which particular periods during the run the greatest proportion of faulty articles are produced.

(3) Full cognizance will also have to be paid to the nature of the tolerances allowed on the finished work. These need not necessarily be those limits of

variation specified on the client's blueprints. In many moulding operations, in order to facilitate the actual moulding, or tool-making activities, or the finished accuracy of the work itself, it becomes advisable for the moulder to lay down slightly different tolerances to suit his own convenience. These tolerances are often more stringent or binding than those of the customer, and must be treated as purely for the better guidance and control of the manufacturing processes involved.

(4) The quality, accuracy, age and degree of usage of the mould are also very important points to be considered when making such an estimate. As most plastics moulding engineers will realize, the percentage of defective parts likely to arise from a mould which has been in regular production use for an extended length of time is sure to be much greater than will be produced from a brand-new moulding tool, or one that has only been engaged on a few short-length runs. These factors will, of course, exert a great effect upon the moulder's ability to sustain the quality and accuracy of the moulded products.

(5) Any other apparently relevant factors which the production moulder feels will have an important bearing upon the continued accuracy, smooth operation, and general sound finish of the moulding tools, or those required for secondary finishing operations, will also have to be considered when calculating the above-mentioned estimate.

This estimated value of the overall general level of quality is then known as the " process average defective," and for convenience, in quality control terminology, it is usually referred to by the latter " p," which designation will be employed in the succeeding discussion.

The estimation of this value for each particular moulding job will naturally have to be undertaken with some degree of care and exactitude, because the more accurately it is determined the more satisfactory and reliable will be the results obtainable for the compounded sampling methods introduced later, and based upon such an estimate.

Furthermore, when undertaking this estimate it will not be sufficiently reliable to take into account the results from a single preceding production run. Two or three normal runs from the mould would have to be selected for analysis in the above manner to obtain best results. In the case of a completely new moulding tool, introduced into the shop for the first time, it will mean that the adapted methods of sampling, etc., to be detailed later in these pages, cannot be applied initially during the first production run.

Of course, it sometimes happens that the moulder is able to make a sound estimate of the process average defective on a perfectly new class of work, because a moulding tool of a very similar kind is actually possessed which has the requisite degree of working life to its credit. This would enable the experienced moulder to make a reasonably accurate assessment of the various factors connected with the moulds and how they would be likely to affect production and quality.

Some care, too, will be required in estimating the value " p " on the following count. Merely to take overall figures of the percentage of defects to sound mouldings might give a misleading result because of the following reasons.

The quality of articles produced from any type of mould does not remain at a consistently steady level throughout the entire period of the run. It certainly is one of the objectives of quality control to ensure ever closer approximation to that result, but even with the most successful scheme of inspection, mould maintenance, and general supervision of the moulding operation, a 100 per cent. attainment of this end will not be secured. Far more improved results will, however, be obtained on productions covered by quality control methods than by the use of conventional or customary forms.

Therefore, to avoid confusion and difficulties likely to accrue from taking " global " defective figures, it will be advisable to split up the production run

into conveniently spaced periods. For most general moulding of non-precision components of the kind now under review, the writer would suggest daily intervals, for a reason which will be clear later in this description.

The mouldings produced each day over, say, three previous production runs would be analyzed and the percentages of sound to defective and scrapped components reckoned. This information would be extracted for the output of each day The averages of the acceptable, defective, and scrapped components would then be calculated for each class, and finally added up to give a set of grand average values for each feature covering the period involved.

This preparatory data can be excellently collated and handled by means of a simple graph constructed along the lines shown at Fig. 1. This very clearly and pictorially represents the relationship between good, faulty, and scrap components in such a manner as to be of considerable guidance to the inspector at a later stage when normal production operations are being dealt with, and sampling of the product is conducted at regular intervals.

Referring to this illustration it will be noticed that the three distinct production periods are combined into one, the whole period being sectionalized into daily intervals, which are denoted on the horizontal ordinate, whilst the quantity of articles is indicated on the vertical left-hand ordinate.

Three curves are employed on the graph, one indicating the number of correct mouldings, the second to show defectives, and the last to depict the quantity of completely scrapped parts. Each curve should preferably be indicated by a different colour on the actual graph, in order to promote greater clarity; for the illustration, however, these three important curves are shown by heavy solid lines and broken lines respectively.

At the right-hand side a wide vertical column is provided, this being split up into a convenient number of compartments wherein is inserted the following information.

(1) Total parts produced during entire period under review.

(2) Total defects in whole period.

(3) Percentage of defects in period.

(4) Daily average percentage of defects.

(5) Total scrap produced in period.

(6) Percentage of scrap parts in the period.

(7) Daily average percentage of scrap.

Readers will understand the manner in which this tabulated information is reached, and also its great usefulness to the inspector, especially at a later point for enabling him to make comparisons with the actual production taking place.

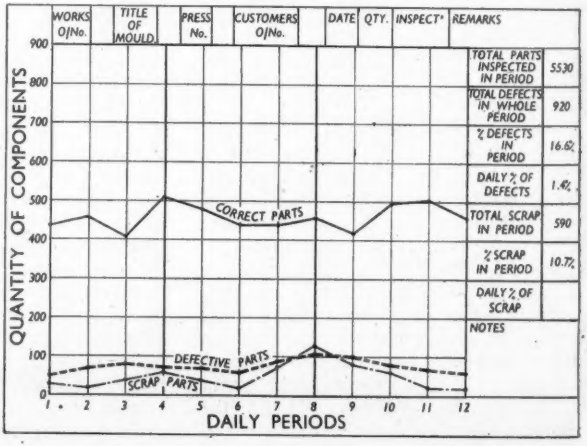


Fig. 1.—Simple graph showing how essential data are collected and recorded for future use.

A number of compartments are also provided along the top edge of the graph, wherein may be entered important and relevant data concerning the job, by means of which the requirements of the work are better identified by all concerned. This information will include works order number; designation of components; moulding press or machine number; customer's order number; date; quantity of parts; person making the check or responsible for inspection; identification of gauges, etc., and a space reserved for remarks or notes for the inspector's use.

Such a graph would be found very useful not only when making the preliminary estimation of the process average defective " p," but may be advantageously employed as a continual counter check or reference throughout the ensuing normal production.

As already stated the graphs record the daily variations which have taken place in the quality or accuracy of the finished moulded articles over three preceding test periods. With the compound type of sampling about to be described, an inspector would make at least one check per day of the components produced during that period.

By constantly referring to the graph he would be enabled to check whether or not the daily production was being maintained within proper control, because the proportion of sound to defective and scrap components should not be substantially greater than the average value depicted on the graph. It will be explained, however, that a further important check on this aspect of the production is provided under a system of compound sampling, which ensures that considerable reliance can be placed upon the information recorded in the graph. This information does, of course, afford a clear indication of the trends occurring in the production process.

In making such an estimate of the value " p," it will also be necessary for the production moulder to take into account not only the extent and range of variations, which have actually occurred during the two or three test periods selected, but also to arrive at a reliable scale of quality or accuracy which it is considered the moulding shop is capable of producing consistently, and which, of course, would be acceptable to the customer.

The third point to be considered when making the process average defective estimate is that of batch size, which is the concern of the inspector. It would naturally be unwise and give unreliable results if the estimate of the above value were to be based on batches of, say, 250 components per day, and later, when actual production is under way, to select batches of a 1,000 parts for compound sampling purposes each day.

Inspection and Double Sampling Procedure

The inspection procedure will be as follows: Having determined satisfactorily all the above-mentioned points, deriving therefrom the estimate of the value " p " applicable for the job in hand, quantities of finished components should be transferred to the inspection department at regular daily intervals for the taking of samples and checking.

From each batch of components thus produced the inspector would take, quite at random, a sample batch of a given quantity. The size of this sample batch will be conditioned by the value allotted to symbol " p," which has previously been assessed. The manner in which the size of sampling batch is derived will be more fully explained at a later point.

Having selected his sampling batch of, say, " n " moulded parts, these would be gauged or measured by the usual " go-not go " gauges, or any of the other common forms of measuring instruments chosen as being suitable to the requirements of the job. If the number of defectives found does not exceed a given figure, generally noted in quality control parlance as " c," the whole lot of parts from which this sampling batch was taken would then be regarded as within the limits and accepted as satisfactory.

If, however, the number of defectives found in such a sampling batch exceeds

"c_1" but is below "c_2", a second sample group denoted by the symbol "n_2" would be taken from the same lot of parts and a similar check made as in the first case. It is worth while interposing here the point that the quantity of parts which usually has to be taken at the second sample is considerably larger than the first batch. If the total number of defective components accruing from both the first and second sampling batches is found not to exceed "c_2", the entire batch would be accepted.

Should the total quantities of defectives exceed the figure denoted by "c_2", however, the entire batch would have to be given a 100 per cent. inspection check.

Again, in respect of the first sample batch taken, that is, "n_1", if it is found that the number of defectives exceeds value "c_2", then again a complete 100 per cent. check would be necessary before passing as correct the quality or accuracy of the whole batch.

The values for "n_1", "n_2", "c_1" and "c_2" are determined by the value "p," that is, the process average value; the quantity of the lots taken from the moulding machines; the average level of quality it has been estimated as being acceptable to the customer; and a fourth condition symbolized by "p," which is an overall tolerance introduced in order to limit the risks of any individual sampling batch getting through without a proper check.

Tables have been carefully compiled by quality control statisticians, giving the respective figures for numerous ranges and values of the process average defective "p" and the factor "p," in relation to the particular lot size employed. Such a table will be found in "A First Guide to Quality Control for Engineers," to which reference has already been made.

An Actual Example of Compounded Sampling

Although from the foregoing description this process of quality control inspection by double or compound sampling may sound somewhat complicated, in actual practice it is really exceedingly simple and easy to understand, especially so because so little clerical work is involved.

Its application, operation and usefulness will perhaps be better understood by selecting a particular moulding job as an example, working through the various stages for the setting up of quality control over the processes in the way just described in order to show just how the system of compound sampling is applied.

For example, suppose we have an injection moulded component which is furnished with fairly wide limits in regard to dimensional variations, weight, surface finish and any other specific features. These tolerances, let us further suppose, are of such a kind that it is unnecessary to have frequent gauging or checking of small sample batches in the manner which is necessary with ordinary forms of fraction defective quality control methods.

With an hourly production of 200 of these injection mouldings from a multi-impression tool, as the outcome of tests conducted on three previous production runs, each of several days' duration, it has been estimated that the general production is on the average 2 per cent. defective. This average it will be appreciated is based on a daily output of between 1,200 to 1,500 components, and constitutes value "p" for the work.

To ascertain the respective values of n_1, n_2, c_1 and c_2 we must now turn to the tabulated figures given in the booklet just mentioned. Here we find that n_1 equals 150 components; c_1 equals 1; n_2 equals 325 components; and c_2 equals 9.

Transferring these values back to our actual moulding example, their interpretation means that the inspector will have to take a first sampling batch (n_1) of 150 individual components from the daily output received. This sampling batch would then be given a careful check or gauging where necessary, every individual moulding, of course, being treated. If the result of such a check produces more than one defective, a second sampling

batch (n_2), consisting of another 325 components, must be taken from the production lot under review, and similarly gauged, as in the first case.

If the result of this second sampling batch produces a total number of defectives over both the sample batches n_1 and n_2, that is, from among the 475 components the defectives exceed 9, then a full 100 per cent. inspection check will be required on the remainder of the 1,500 components in the daily output lot; that is, the remaining 1,025 components would have to be thoroughly checked in all respects.

These various inter-connected steps in an inspection procedure are depicted in simple table form at Fig. 2, which will render their application to any general inspection operation quite clear to readers.

Referring again to the table from which we have obtained the respective values for the factors n_1, n_2, c_1 and c_2, it will be noted that an additional value is given against each set of values for the above factors. This relates to the average overall quality of the parts, and in this particular example this value is rated at 1 per cent.

This means that with the scale of inspection just described, based upon double or compounded sampling the quality of the components in the full 1,500 batch of parts from which samples have been taken, cannot be more than 1 per cent. defective under any circumstances, and in all probability will be appreciably less than this figure. It is a ceiling value, demonstrating the maximum number or proportion of defects and scrapped parts which will arise with double sampling.

Thus the inspector is immediately appraised of the worst condition or quality of the parts which may occur, and should this figure of 1 per cent. coincide or fall below the estimated value previously calculated for the job in question, the inspector is assured that the due level of accuracy or quality will be maintained.

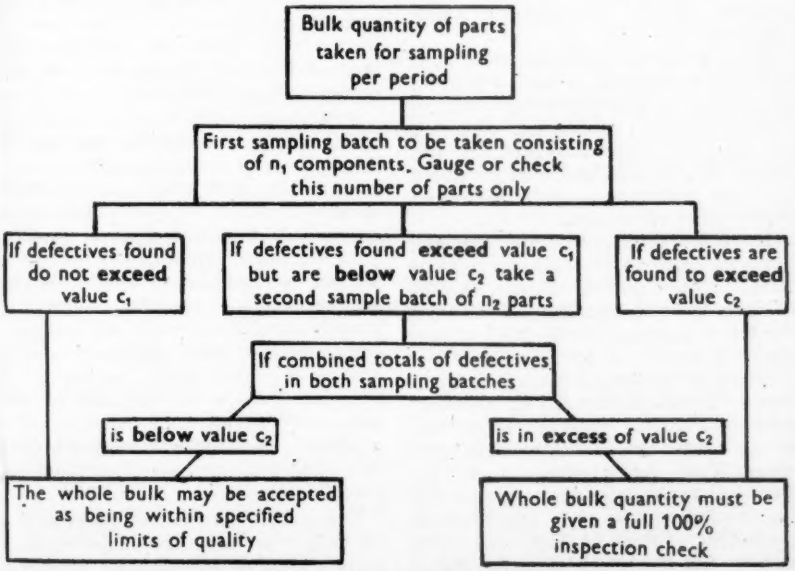

Bulk quantity of parts taken for sampling per period
First sampling batch to be taken consisting of n_1 components. Gauge or check this number of parts only
If defectives found do not exceed value c_1
If defectives found exceed value c_1 but are below value c_2 take a second sample batch of n_2 parts
If defectives are found to exceed value c_2
If combined totals of defectives in both sampling batches
is below value c_2
is in excess of value c_2
The whole bulk may be accepted as being within specified limits of quality
Whole bulk quantity must be given a full 100% inspection check

Fig. 2.—Table illustrating respective steps in double sampling operation.

As readers will appreciate this simple method will generally result in very considerable reductions of inspection time and effort, a very important consideration when dealing with non-precision type plastics mouldings.

Operating Features of Scheme of Inspection

When operating this form of quality control by compound sampling, the respective values for factors n_1, n_2, c_1 and c_2, would be previously ascertained either in the design or production department, as it would be unwise to leave their determination to the inspector concerned. At the commencement of a new production run the inspector would be supplied with all the requisite data on these and kindred points, this being issued preferably in orderly tabulated form in the manner shown at Fig. 2, thereby giving him precise guidance and instruction concerning the various steps to be followed throughout the entire inspection procedure. If this is done, innumerable uncertainties and misconceptions will be avoided, and far more reliable results obtained.

In the actual inspection operation some care will be required in the handling of the batches of incoming components, to ensure that the sampling lots taken are not allowed to become mixed up with each other, or with the bulk quantities until the final quality results have been satisfactorily ascertained.

It will be obvious that after the first sampling batch (n_1) has been gauged or tested in the approved manner, this lot of parts must be carefully isolated until the second sampling batch (n_2) has been similarly tested. If as a result of the checking of the second batch it is found that a full 100 per cent. check is needed, then this second sampling batch (n_2) should also be carefully segregated. Appropriate forms should also be furnished to the inspector to permit this information to be duly recorded in permanent fashion. This not only ensures that the actual inspection operation is rendered more manageable and efficient, but also that permanent records are being compiled automatically as production proceeds. These records would then be carefully filed away for future reference, and their later perusal would probably afford guidance to the planning engineer in determining estimates for new classes of work.

Special containers and relevant facilities should also be provided for the use of the inspector to enable him the more readily to make such isolation of the sampling batches from each other and the bulk production. The design and size of these items will be conditioned by the nature of the components themselves and the manner in which they have to be gauged.

The author has found that by devoting a little careful study to this aspect of the inspection process much time and worry can be saved, since it is surprising to what degree the inspection work can be simplified by the use of appropriate facilities and equipment. At a later point in this series, this aspect of quality control procedure will be discussed more fully, and innumerable examples from actual practice will show the various ways in which the work may be simplified and rendered more foolproof.

Another extremely valuable advantage which is to be derived from the use of this type of fraction defective quality control, viz., that based on compound sampling batches, is that usually very simple and inexpensive kinds of gauging tools can be employed. This arises from the fact that relatively small quantities of components are actually gauged or checked in comparison with what obtains when operating other forms of quality control dependent upon the taking of sampling batches ranging from 20 per cent. to 40 per cent. of the total parts produced, which have to be checked at very frequent intervals throughout a production run.

This reduced amount of gauging will mean that the tools are subjected to a correspondingly less amount of wear, which, in turn, will entail they have a far

longer working life, or, alternatively, much simpler forms of gauges can safely be introduced.

With this system there is also an appreciable reduction in the amount of clerical work involved, because control charts of the type previously described and illustrated in this series are not required. Providing proper written records are kept of each sampling activity at the end of every specified sampling period during a production run, which may then be kept and used for future reference, these are practically the only clerical entries required.

Before concluding, let us now consider what steps will have to be taken in the case of a production run being controlled by double-sampling inspection methods, when it is found that the values c_1 and c_2 are consistently being exceeded.

Obviously, if the inspector has to make repeated 100 per cent. checks on all the components produced during a given period, because the quantity of defectives is on the increase, some steps must be taken to correct this undesirable tendency. Here, one of two steps may be taken.

First, if it is considered that the increase in the defective rate is not unduly steep or rapid, but requires closer watching, the inspector may easily secure this result by taking batches for sampling at rather more frequent intervals for a short period. Thus, in the case of a production run from which the quality is being checked once per day in the manner already described, if the defective rate is rising, closer control can be exercised by taking sampling batches twice per day. To accomplish this, new values would have to be ascertained for factors n_1, n_2, c_1 and c_2, based on the reduced bulk quantity figure.

By adopting this course, the inspector would be enabled to keep a stricter check upon the production trends, and, in the event of a serious increase in the defective rate taking place, the number of faulty components resulting therefrom would be considerably reduced in total.

The second step which may be followed would simply consist in stopping production to make an examination of the mould, or methods being followed by the operator in an endeavour to ascertain the cause of the increase in defectives. Determination of the need for making this inspection of the mould, etc., would be made plain immediately the overall average quality (p) of the production exceeded the estimate allotted to the job in the first instance.

The inspector would, of course, be constantly on the look-out for the above condition, which, should it arise, would at once indicate the necessity for shutting down production in order to investigate the cause. By these simple means the work can easily be maintained within the requisite limits and degree of control throughout even a lengthy production run.

Yet another interesting point covered by this method of inspection is that the rate of scrapped components is similarly capable of being controlled. This is secured in the following manner:—

Referring to the graph at Fig. 1, it will be noted that one curve relates to the average scrap made during the three test production runs. If during the respective daily gauging operations on the sampling batches n_1 and n_2, the inspector finds that this daily average is being exceeded, he will at once understand that some action is required.

The figure of the maximum permissible scrap would be previously calculated and given to the inspector at the commencement of the production process. This figure would take the form of a percentage ratio for each size of sampling batch, n_1 and n_2 respectively. Any excess of this figure in any single sampling batch would then entail an immediate stoppage of the production and some examination of the moulding tool, etc.

With this system of control the tolerance stipulated for defective workpieces should be of such a scale as to enable such parts to be easily corrected. It would be most unwise to give unduly wide tolerances approaching too closely

to the drawing tolerances laid down by the client's requirements. Were this to be permitted, it might arise that large quantities of the actual defects found during the various gauging operations could not be rectified since many of them would lie outside the drawing tolerances.

This would occur because the control is effected by means of average values only, as readers will appreciate from the foregoing description. Thus the average level or accuracy, finish, or other features would only lie within the tolerance laid down at the outset.

Incidentally this is a most important point to be borne in mind in respect of all forms of quality control by fraction defective, these being founded upon such average values. Consequently, when the plastics moulder determines working tolerances for the convenience of the moulding processes involved, due regard must be paid to this aspect of quality control procedures.

In the case of control methods by compound or double sampling, the author has found it advisable to employ working tolerances on all dimensions or other measurable features of not more than half those laid down by the drawing of the component, or the specifications of the customer. Tolerances between 30 per cent. and 50 per cent. of the drawing limits will be found in practice to afford an adequate latitude for the variations occurring in the average values employed, sufficient in fact to ensure that all parts discovered as defective shall be capable of being rectified and brought within the drawing limits.

In this manner, therefore, it is possible to maintain the rate of scrap within small limits, which limits will be conditioned solely by faults, or damages occurring in the moulding tool, etc., and not because of the use of average values in the statistical side of the control methods.

(To be continued.)

PLASTIC INSTITUTE NOTES

Diplomas.—Awards have been made to Messrs. W. B. Brown, L. S. Tait and H. T. Williams.

Prize Papers.—The Institute has decided to recommence the Prize Papers Scheme. The object of this scheme is to encourage a high standard of papers given by members of the Institute and thereby assist the interchange of technical data, original ideas, and experience. Two classes of award are offered:—

(a) A silver medal, to be called the Plastics Institute Silver Medal, will be open for competition by any member of the Institute and will be awarded to the author of the paper read before any Section of the Institute and adjudged to have the highest merit. This medal is to be an award for a paper outstanding in usefulness to the industry from a technical, practical, commercial or other suitable standpoint.

(b) Bronze medals, to be called the Plastics Institute Bronze Medals, will be given for the best paper submitted, not necessarily read, and will be open for competition by Junior Members of the Institute, students taking recognized courses in plastics, and apprentices under the Institute Apprenticeship Scheme.

Deferment from National Service.—The Ministry of Labour and National Service may grant deferment for a period of six years to a man training in employment with concurrent part-time study, subject to the following conditions:—

(1) Candidates must have commenced a course of professional training (having passed or been exempted from any necessary preliminary examination in general education) by the age of 17, or within three months of the completion of their general education, or of the end of deferment, which they may have been granted to remain at school to the end of the school year in which they attain the age of 18.

(2) Students must be registered with the Plastics Institute, and must furnish a certificate from the Institute showing that they are receiving approved practical training and that they are following an approved part-time course of study leading to the Associateship examination.

(3) Students must be allowed time off for study during working hours, to the extent of 8 hours per week.

B.S.S. 488: 1948. This specification, first published by the British Standards Institution in 1933, has now been issued as a revised standard.

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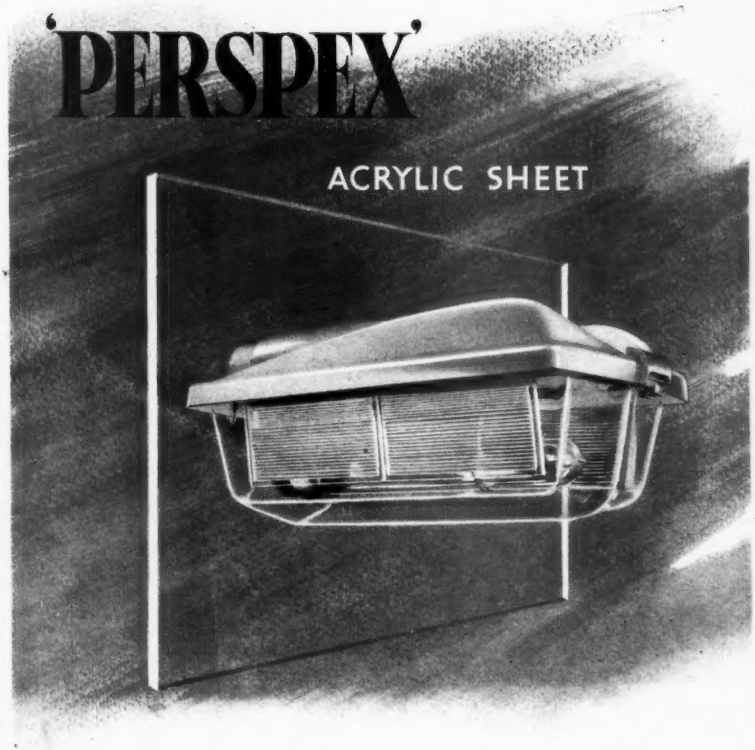

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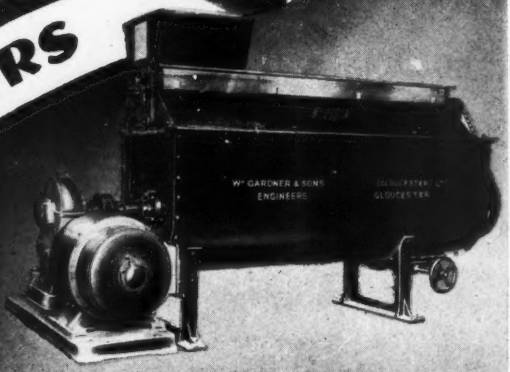

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The Microscopic Examination of Plastic Materials

VII.—Mouldings (Contd.)

By J. H. WREDDEN, F.R.M.S.
(Chief Chemist, Igranic Electric Co., Ltd.

HAVING examined the coconut-shell filled moulding in some detail and noted the differences in structure apparent when compared to the previous materials, it is of some not inconsiderable interest to investigate the effects produced by a mixed filler. Thus, it is proposed to examine, under the microscope, a moulding filled with a mixture of coconut-shell flour and standard wood flour produced from Swedish softwood; but before going into the details it is of interest to note that these two materials are so different, structurally and from the point of view of texture, that interesting possibilities might be expected.

Although we have not, as yet, dealt with standard wood flour filled mouldings, this material was chosen as the second component in the filler as being greatly different in structure and texture; any differences in the resultant structure would, presumably, be more clearly defined. The mixed filler itself does not produce strengths as great as the pure coconut-shell flour, and, as can be imagined, the ultimate strength of mouldings filled with this material varies according to the proportion of coconut-shell flour present.

When examined at low magnification the structure of this moulding is seen to be somewhat as expected. That is to say, the hard, inflexible coconut-shell particles are seen to retain their typical structure, just as they do when this material is used as a filler itself. In Fig. 337 is seen a portion of a moulding filled with the mixed filler, at a magnification of 26 diameters. From this illustration it will be seen that the shell particles, such as those marked A and B, appear to be suspended in the background mass, which, of course, consists of the resin and wood flour. The feature of immediate significance is the manner in which the particles of coconut-shell are kept separated by the wood flour. This is understandable as the wood flour is soft and "fluffy" when compared to the shell, and would be expected to act as a cushion material surrounding the shell particles, and, as during the stage in the moulding cycle when the resin is liquid, the whole mass of resin and wood flour would possess a greater degree of mobility than the shell particles, the flowing of this mass around each shell particle is rather to be expected than otherwise. At the same time, the development of this condition

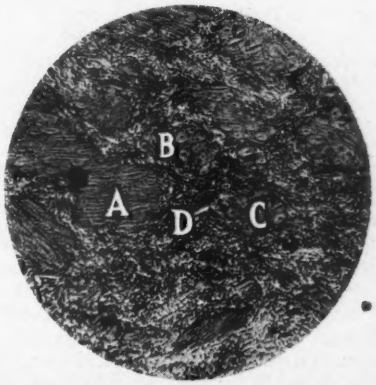

Fig. 337.—Section of moulding filled with mixture of coconut-shell and wood flour. Mag. 26 diameters.

would be aided by the piling-up of wood flour particles on the outer surfaces of the shell particles, due to the structure of these latter functioning in some respects as a filler. This is not unexpected, in view of the fluidity of the resin and the ease with which the particles of coconut shell appear to be impregnated.

In view of this, we should expect to find some signs of this piling-up, or local concentration of wood flour, and in the illustration under consideration signs of this are evident in localities such as the area marked D, between the three shell particles A, B and C. It should be borne in mind, however, that at this magnification it is difficult to form any definite conclusion regarding this; however, there are more definite indications of flow patterns in the resin-wood flour mass which tend to support the assumption. Thus, the three shell particles just mentioned are seen to be so positioned as to give rise to the formation of quite definite channels, in which the orientation of the wood flour seen to be present is indicative of flour in the channels. Although the magnification is not sufficient to enable conclusions to be arrived at regarding the details of the flow, the most one can say is that the photograph shows how the wood flour mass surrounds the shell particles and appears to flow around them, and at the same time there appear to be signs of the filtering action of the shell structure.

As a result of the presence of the wood flour, one outstanding characteristic of the structure produced by this mixed filler is, what appears to be, the suppression of flow patterns developed in the shell portion of the filler. In the examination of the coconut-shell filled moulding ("Plastics," September and October, 1948), it was shown that these were pronounced and definite, particularly near the surface, where the blocking effects were also observed. In the material now being considered, the wood flour seems to be effective in preventing this phenomenon, for in Fig. 337 the shell particles do not show any such tendency to orderly arrangement, with

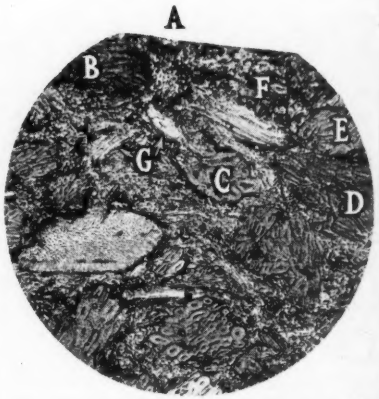

Fig. 338.—Coconut-shell and wood flour filled moulding: transverse section showing general structure at surface. Mag. 26 diameters.

the exception, perhaps, of a slight tendency towards horizontal orientation, although this latter is somewhat vague, due, firstly, to the shape of the shell particles and, secondly, the effective separation achieved by the wood flour.

This is well shown in Fig. 338, illustrating another portion of the same section, also at 26 diameters. This photograph shows the shell particles to be well separated from one another, with little signs of any sort of orderly arrangement. In spite of the fact that the portion shown includes a part of the surface of the moulding seen at A, near to which is a group of shell particles B, C, D and E, it would appear from the arrangement of these latter that there was a tendency to close grouping, which might have resulted in blocking, and the consequent production of a clear-resin mass in the region of A. However, as this area is occupied by a mass of wood flour and resin, it is obvious that blocking has been prevented.

The reason for the efficacy with which this occurs is not immediately apparent, but it should be remembered that the structure might be considered as a two-component material; that is to say, the coconut-shell flour functioning as a filler

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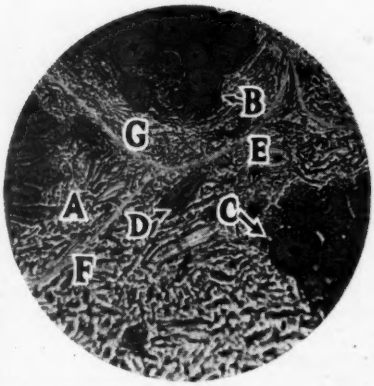

Fig. 339.—Coconut-shell and wood flour filled moulding: transverse section. Mag. 100 diameters.

for a mixed matrix material consisting of resin and wood flour. When considered in this way the shell particles are seen to behave somewhat in the manner exhibited by the coconut-shell filled moulding, thus the area at the surface (A) would be considered as being a mass of pure matrix material corresponding to a clear resin mass in the previously examined mouldings. Although in the present case the phenomenon of blocking is not so clearly defined, it should be borne in mind when considering the matrix material in this manner, that what amounts to the resin mass will be very much stiffer during the fluid period of the moulding cycle than would be the case with resin only. It will be appreciated that when the structure is thus considered, the difference existing between the two components is clearly emphasized.

It will be noticed that, in general, the wood flour appears to be of very fine mesh, as complete particles of wood, whose size is comparable to that of the coconut-shell particles, are few and far between. This structure is interesting, because the flour used in blending the filler was standard 80 to 100 mesh Swedish wood flour, and as such it is to be expected that individual particles would be detectable in somewhat greater profusion. However, as can be seen, this is not so, and the wood flour in this moulding appears to be somewhere in the region of 200 mesh. From this it would appear likely that at some stage in the processing the wood flour component undergoes a certain degree of modification whereby it is further reduced.

This reduction is not universal or complete by any means, as evidenced by the presence of wood particles of appreciable size at F and G in Fig. 338. In general, however, this question is not clearly elucidated at the low magnification of 26 diameters, so it is expedient to examine the section at higher magnifications such as represented by Fig. 339, showing a portion of the section at 100 diameters, which clearly shows the general structure of the wood flour to be somewhat indeterminate and composed of very small particles, mainly individual tracheids or portions thereof. This condition leads to speculation on the reasons for this phenomenon appearing, as the reduction which the wood flour appears to undergo is quite considerable and constitutes a problem of major importance.

Although there is no information other than the microscopic image available, offering a solution to the problem, it is worth while considering it in the light of the visual image, which depicts the wood flour to be in the afore-mentioned condition. Thus, assuming that reduction occurs to the degree apparent, the problem resolves itself into one of finding the reason for this occurrence. Anent this, it is probable that the presence of the coconut-shell flour is the key factor in the solution. This material has been shown to be hard and unyielding in its granular form, and it is highly probable that during the processing the wood flour is milled further by the action of the shell particles. It is suggested that the most likely point at which this occurs is during the incorporation of the filler into the resin on the rolls. Some measure of support is given to this hypothesis by the presence in the wood flour of single shell elements, such as that shown at D (Fig. 339), which

is obviously such an individual and could conceivably have originated by being rubbed off larger particles, such as those shown at A, B and C.

This hypothesis is of some interest, inasmuch as it suggests that the use of blended fillers must take into consideration the possibility of physical modification of one or more components of the filler by mechanical forces, because the nature of the component so altered will vary from that which existed before incorporation into the moulding powder. In consequence of this, it is impossible to forecast the final characteristics, produced by any particular blend, on information known about the individual components when used as fillers separately. However, the reduction of the wood flour in the case under consideration is hypothetical, as there is not sufficient evidence to prove the manner of its production, and must be regarded as such until further data are available. The only point which can be regarded with any certainty is the almost entire absence of larger particles of wood in the form in which they composed the majority of the wood flour before incorporation into the moulding powder.

There are other points of interest in Fig. 339, chief of which is the presence of very definite and clearly defined flow patterns around and between the shell particles. The channel between the particles marked A and B exhibits this very clearly, by virtue of the strong longitudinal orientation of the wood particles in the mass in the channel.

Concerning this orientation, it is interesting to note that it extends outside the channel around the periphery of the particles in question as a layer of material more highly orientated than the remainder and indicated by the two lines E and F. These areas would appear to indicate the formation of a tightly packed layer of wood flour particles covering each shell particle, and where two of these latter lie close together, such as A and B, then the layers in the channel coalesce on an indefinite plane shown by the dotted line G. Any pressure between two such particles would obviously cause the wood flour to pack more densely after a portion had been squeezed out. Thus a certain amount of flow would exist, causing the orientation of the wood particles at the point of intersection of the lines E and F to be somewhat disturbed.

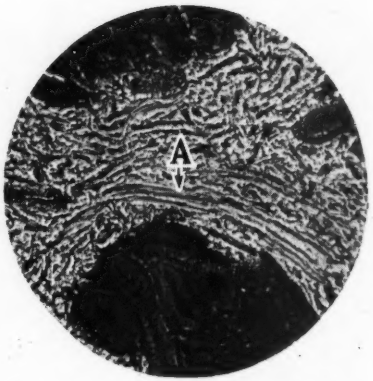

Fig. 340.—Coconut-shell and wood flour filled moulding: section showing flow patterns. Mag. 100 diameters.

Further evidence of the formation of layers of wood flour and resin-ground shell particles is seen throughout the section. This is particularly well demonstrated in those places where fibres of appreciable length are seen to exist in the masses. In Fig. 340 the long wood fibres marked A are seen to lie on a "bed," as it were, of smaller wood particles surrounding the shell particle. These are seen to form a tightly packed layer on the surface of the shell unit. At the same time a similar condition is visible around the other shell particles seen in this illustration. It is reasonable to suppose, therefore, that in the initial stages of the moulding cycle the formation of this layer occurred previous to any great movement in the wood component, thus accounting for the apparent attempt of the long wood fibre to conform to the shape of the shell particle against which it is lying.

As a result of the layer formation, it

might be expected that the size of channels formed between the shell particle would be somewhat restricted, but our study of the section shows that this is not so, because if it is assumed that the limits of the channel boundaries are laid down by the outer surfaces of the peripheral layers on the shell particles, then it will be seen that there is very little difference between the sizes of the channels in the section under consideration and those seen in the previously examined specimen filled with coconut-shell flour only. This is due to the greater distances existing between shell particles, in this case mixed, brought about mainly by the presence of the wood flour acting as a cushioning material and also, to some extent, by the early formation of the hard pack layer of wood particles increasing the effective size of the shell units. Thus even if there were no true channels present, we should expect to find what might be termed false ones whose width would be twice the thickness of the wood layers.

In view of this it is evident that as the channels are formed in the aforementioned manner, flow or movement in them would be somewhat restricted, and this is found to be the case as the results of such particle " movement " are not so apparent as in the case of the pure shell filler. It would, therefore, seem to be advisable to look upon this material as mixed matrix (consisting of resin and wood flour) containing a coconut-shell filler, and, indeed, this would appear to be the case in any two component fillers in which the components are of such widely divergent types as in the present case.

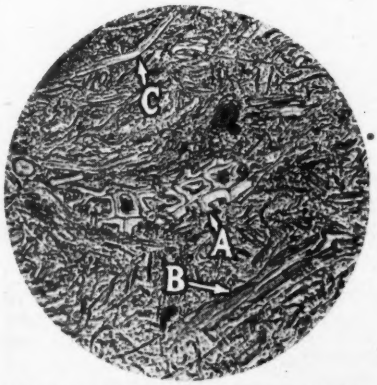

Fig. 341.—Coconut-shell and wood flour filled moulding: section showing wood structures. Mag. 100 diameters.

Up to the present we have not examined the wood flour component in any great detail, and it is therefore proposed to discuss the structure of this portion of the section. It has been pointed out previously that the structure of the wood particles has appeared to have undergone considerable modifications, due, presumably, to a grinding action developed by the hard coconut-shell particles during the mixing on the rolls. That some such action occurs is evidenced by the great difference in structure between the wood flour in the section and the known structure of wood flour, which was discussed in the section on fillers.

In the case under consideration the particles have lost their individuality and appear as if defibrated to the limit. A good example of this general effect is seen in Fig. 341, showing a portion of the " matrix " at 100 diameters. The appearance presented by the wood flour generally indicates its composition to be individual tracheids, except for one or two isolated cases where a group of histological elements is seen to be present, such as at A. This structure is typical of the softwood where the tracheids are rectangular in transverse section, and in spite of the vessels having been subjected to a certain amount of distortion in the processing, they are still identifiable as soft tracheids. Likewise a small bundle of tracheids, seen in longitudinal section at B, appears to be composed of portions of large elements.

In general, the wood particles in this section consist of single tracheids, in some cases of appreciable length, as exemplified by the one shown at C, but in the majority of cases they are very much shorter. As a result of this further reduction of the wood flour, the question

Fig. 342.—Coconut-shell and wood flour filled moulding: section showing flow patterns. Mag. 100 diameters.

arises as to what possible effects this may have on the characteristics of the finished moulding, for it is clear that the wood flour in the condition shown must be equivalent to a very fine mesh product in normal circumstances. Bearing in mind that the optimum strength produced by wood flour is given by a product of 80 to 100 mesh, it would seem likely that the strength conferred by the wood flour in this case may be expected to be somewhat less than that produced by standard 80-mesh material, but the moulding in question possessed the same strength as a standard wood flour filled moulding. The addition of the coconut-shell flour had the effect of allowing an economy in resin so that the same final strength is present with less resin. This would appear to show that the presence of the coconut-shell results in an added strength and may be used for economizing in resin. However, it is suggested that if the wood flour used is in the first instance of a coarser grade than the usual 80 mesh, then it might be expected to be reduced to something like the optimum mesh size in the final product, thus producing a further increase in the strength of the moulding.

It will, of course, be obvious that one cannot reduce the resin content indefinitely as a lower limit is set for this component by the rolling conditions, but it seems probable that, by adjusting the mesh size of the wood flour in this particular case, the effect of the one component of the filler on the other may be utilized to produce a condition where the optimum strength possible is obtained in the moulding. However, there is still a great deal of work to be done on the behaviour of blended fillers, and in the absence of more definite information regarding the interaction of the blended components, the foregoing conclusions can only be regarded as hypotheses on which further work may be based.

Examination of this section has resulted in the production of some interesting information regarding the behaviour of a mixed filler of this type. Perhaps the most outstanding of the characteristics not so far discussed in any great detail is the almost entire absence of evidence demonstrating the existence of regular particle orientations. In the previously examined specimens it was shown that this phenomenon occurred to a somewhat marked degree in each case, depending on the nature of the filler used. In the present example, however, orientation appears to be lacking, for the coconut-shell filler particles do not take up, or form, regular structures such as those seen during the examination of the moulding using it as a pure filler.

From this it is probable that, as the particles are prevented from coming into contact with one another by the formation of the investing layer of hard-packed wood, their mobility during the fluid stage of the process is considerably reduced. Likewise, the general mobility of the mass is also less in this case, due to the modifying influence of the fine particles of wood flour.

In view of this, a lack of orientation is rather to be expected than otherwise. Thus, it will be noted that flow patterns in the compound matrix are also very indeterminate, although there are more or less isolated instances where certain rudiments of flow patterns are seen to exist. For example, Fig. 342 shows one

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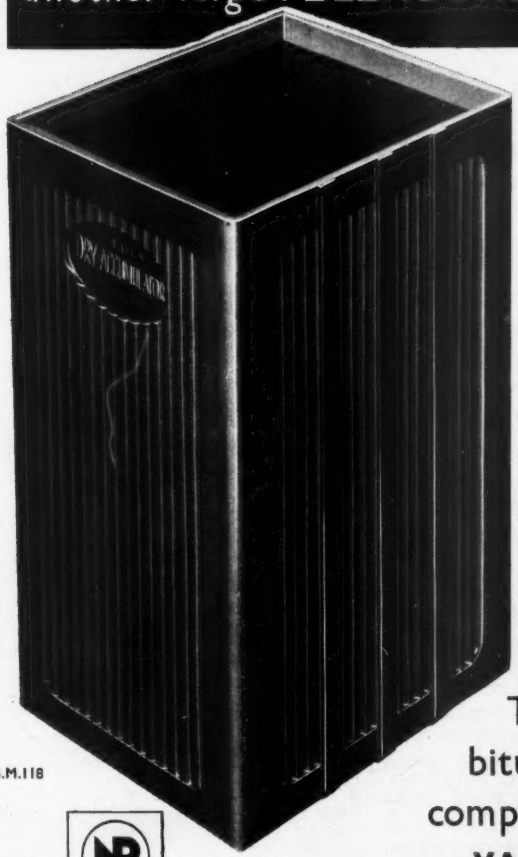

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Fig. 343.—Coconut-shell and wood flour filled moulding: section showing extraneous particle (flax shive). Mag. 100 diameters.

such case, where a certain amount of flow is seen to be present in a channel formed by the configuration of shell particles, which are not seen in the illustration. However, the main pattern may be distinguished as existing between the dotted lines where the structure of the matrix shows a distinct tendency towards horizontal orientation.

Thus, it would appear that one of the effects of this fine texture is to inhibit internal turbulence during the moulding. This is understandable when it is realized that the wood exists in the form of soft, flaccid units which would give way in themselves somewhat, and more so as a whole under the influence of forces tending to bring about turbulence. In this way the internal stresses are very well relieved, in consequence of which there is no evidence of resin crazing.

The effect of the presence of wood flour in relieving the internal stresses and inhibiting the development of a marked degree of particle orientation is, in some respects, desirable, as the strength of the finished moulding tends to be the same in all directions, which is not the case where orientation occurs to a relatively high degree, with its consequent greater strength in one direction.

One aspect of the examination of these mixed fillers, which promises to be of some use for diagnostic purposes, is the manner in which particles other than those of the filler components stand out under the microscope. In cases where the filler is unknown, it is a comparatively simple matter to establish the presence of a mixed filler in the first instance, and having done this the presence of odd particles of extraneous materials is simply ascertained. For example, Fig. 343 shows a particle of flax shive in the section under consideration, the magnification being 100 diameters. From the knowledge already obtained from the examination of a shive-filled moulding, this structure is typical of the flax-shive particle, and there is little doubt regarding its identity. The most interesting aspect of the case is the effect of its presence in the general structure of the moulding.

Of the factors tending to produce a disturbing influence in the structure as a whole, its size is probably the most pronounced, for it is, of course, considerably larger than the average particle in the filler proper. Its structure will also exert some influence on the behaviour of the actual filler in this locality. Thus, it will be seen that there is a tendency to form only a very thin layer of wood particles on its outer surface, due to a restricted flow of the resin into the structure of the shive particle. At the same time, the cushioning effect around the coconut-shell particles is seen to have diminished to the extent, in one case, of allowing a shell particle to come into contact with the shive particle. Therefore, at this spot we might expect to find certain structural weaknesses, but in view of the fact that particles such as these occur very rarely in well-produced powders, their total influence may be considered to be small.

However, it is possible that the number of extraneous particles might reach more considerable proportions, in which case their effect on the general structure of the moulding must be decided.

(To be continued.)

PATENT REVIEW

The following abstracts have been made from specifications at the Patent Office with the permission of the Controller of H.M. Stationery Office. Complete specifications can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

B.P. 602,126. Application date: 12.10.45. Accepted: 20.5.48.

Improvements in or relating to the Production of Optical Lenses and other Devices having an Optically Accurate Finish. To: Combined Optical Industries, Ltd.

Refers to the moulding of plastic lenses, the novelty being the application of high frequency for heating of the plastic.

B.P. 602,131. Application date: 15.10.45. Convention date (U.S.A.): 8.11.44. Accepted: 20.5.48.

Artificial Eye. S. F. Erpf, V. H. Dietz and M. S. Wirtz.

B.P. 602,166. Application date: 23.12.43. Accepted: 21.5.48.

Improvements in or relating to the Production of Synthetic Resin-fatty Oil Compositions. J. D. Morgan, B. Frenkel and L. R. Anthony. To: British Resin Products, Ltd.

Manufacture of resin-fatty oil compositions by dissolving or dispersing in a fatty oil, an amine-modified phenol-aldehyde type resin and incorporating a filler, pigment colouring agent, vulcanizing agent, accelerator, dryer, etc.

B.P. 602,173. Application date: 18.4.45. Convention date (U.S.A.): 12.4.44. Accepted: 21.5.48.

Laminated Waterproof Fabrics and Process of Producing the same. To: Sylvania Industrial Corp.

Waterproof fabric produced by applying to each side of an open mesh textile fabric a film of an organic hydrophobic, thermoplastic material supported on a temporary backing sheet, and applying heat and pressure to cause the plastic film to adhere to the yarn and to fuse together in the meshes. The backing sheet is subsequently stripped off.

B.P. 602,312. Application date: 26.6.44. Accepted: 25.5.48.

Improvements in Resinous Compositions. J. J. P. Staudinger and M.D. Cooke. To: Distillers Co., Ltd.

Stabilization of vinyl chloride polymer or copolymer composition by adding an alkali or alkaline earth metal or ammonium metaphosphates, borates, silicates or carbonates in powder form or in solution.

B.P. 602,314. Application date: 15.8.44. Convention date (U.S.A.): 6.8.43. Accepted: 25.5.48.

Improvements in Coatings and Laminations. A. Marks.

Method of forming an optically isotropic lamination by applying a liquid plastic solution (polyvinyl acetal) to the surface of a transparent support, rotating the support to spread the solution uniformly over the support in a very fine layer, drying the latter and covering the said coating by bringing it into adhesive contact with another similarly formed coating on a support.

B.P. 602,321. Application date: 23.11.44. Accepted: 25.5.48.

Improvements in the Fabrication of Tubing. C. E. Slaughter.

Fabrication of tubes by extruding a heated thermoplastic material through a die in order to form a tube which becomes self-sustaining upon cooling, filling the tube with a liquid before cooling and drawing the tube which is still plastic through another die to give it a circular or polygonal cross-sectional shape.

B.P. 602,360. Application date: 23.8.45. Patent of addition to B.P. 600,490. Convention date (France): 29.4.42. Accepted: 25.5.48.

Manufacture of Solutions of Polymerized Styrene Compounds. To: Société Rhodiaceta.

Solutions containing polystyrene or styrene copolymers in carbon disulphide and at least one other organic liquid (e.g., acetone).

B.P. 602,434. Application date. 19.12.45. Convention date (U.S.A.): 2.1.45. Accepted: 26.5.48.

Process and Apparatus for Forming Films and Coatings. C. S. Francis, Jr.

B.P. 602,444. Application date: 25.7.41. Accepted: 27.5.48.

Coating Composition. G. H. Young.

Protective coating containing a resinous polymer obtained by copolymerization of vinyl chloride and an acrylate or methacrylate, a solvent and quinoidine as stabilizer.

B.P. 602,499. Application date: 25.9.45. Convention date (U.S.A.): 31.3.43. Accepted: 27.5.48.

Improvements in or relating to the Manufacture of Butadiene. To: Phillips Petroleum Co.

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B.P. 602,532. Application date: 16.10.45. Accepted: 28.5.48.

Improvements in and relating to Lampshades. L. V. Williams and P. E. C. Newman.

Lampshade comprising a plurality of independent elements detachably connected together by means of press-stud fastenings so that the shade may be readily collapsed or built up.

B.P. 602,549. Application date: 17.10.45. Convention date (U.S.A.): 18.10.44. Accepted: 28.5.48.

Improvements in or relating to Filaments comprising a hydrolysed Interpolymer of Ethylene and Vinyl Organic Ester. To: E .I. Du Pont de Nemours and Co.

B.P. 602,550. Application date: 17.10.45. Convention date (U.S.A.): 18.10.44. Accepted: 28.5.48.

Improved Drawn Fibres of Ethylene/vinyl Organic Ester Interpolymers. To: E. I. Du Pont de Nemours and Co.

B.P. 602,565. Application date: 12.11.45. Convention date (U.S.A.): 17.11.44. Accepted: 28.5.48.

Improvements in or relating to the Production of Moistureproof Sheet or Film. To: British Cellophane, Ltd.

B.P. 602,583. Application date: 27.2.46. Convention date (U.S.A.): 27.2.45. Accepted: 28.5.48.

Improvements in or relating to the Production of Moistureproof Sheet or Film. To: British Cellophane, Ltd.

B.P. 602,615. Application date: 24.8.45. Convention date (France): 22.8.41; 25.10.41. Accepted: 31.5.48.

Improvements in or relating to Rubber-like Products and Manufacture thereof. Les Usines de Melle.

Refers to copolymers of butadiene-1-3 with methylene chloride, malonic esters, cyanoacetic esters, aceto-acetic alkyl esters or acetylacetone.

B.P. 602,665. Application date: 6.11.45. Accepted: 1.6.48.

Improvements in the Manufacture and Production of Porous Plastic Masses from Polymerized Vinyl Compounds. L. J. Cardy and G. T. Gammon. To: Imperial Chemical Industries, Ltd.

Porous plastic mass produced by mixing into a dispersion of finely powdered polyvinyl compound a practically non-volatile plasticizing agent, in which the compound will not dissolve at ordinary temperatures, adding ammonium carbamate powder and subsequent gelatination by heat. The mass so produced is especially suitable for shoe soles.

B.P. 602,817. Application date: 4.9.45. Convention date (U.S.A.): 22.11.44. Accepted: 3.6.48.

Improvement in Moulding Composition and Method of Making the same. To: The Clark Thread and Co.

Thermosetting moulding composition comprising a finely divided filler and the reaction produced of a rosin resin emulsion and a basic alkaline earth metal compound.

B.P. 602,851. Application date: 27.12.45. Convention date (Netherlands): 10.4.43. Accepted: 3.6.48.

A Process for Polymerizing Isobutene with Other Polymerizable Substances. To: N. V. de Bataafsche Petroleum Maatschappy.

B.P. 602,974. Application date: 14.11.45. Accepted: 7.6.48.

Improvements in or relating to the Production of Aqueous Solutions of Polyvinyl Acetate Derivatives. R. R. Lyme. To: Imperial Chemical Industries, Ltd.

B.P. 602,990. Application date: 15.11.45. Accepted: 7.6.48.

Method and Apparatus for Cutting or Trimming Thermoplastic Materials. J. W. Dalgleish. To: Pye, Ltd.

Cutting of thermoplastic materials by closing together upon the material, two electrodes of the desired shape, applying high frequency energy to soften the material, switching off the current supply before dielectric breakdown occurs, subsequently continuing the closure to sever the material completely.

B.P. 603,040. Application date: 16.11.45. Convention date (France): 4.8.44. Accepted: 8.6.48.

Manufacture of Articles from Polymers or Copolymers of Vinyl Chloride. To: Société Rhodiaceta.

Manufacture of vinyl chloride polymer or copolymer articles by treating the polymer with a quantity of volatile solvent insufficient to give a solution at ordinary temperature, forming a swollen mass (without employing a plasticizer) and subsequently extruding the mass under pressure through a suitable orifice.

B.P. 603,076. Application date: 28.2.44. Convention date (U.S.A.): 26.2.42. Accepted: 9.6.48.

Improvements in Organic Siloxanes and Methods of Making them. To: Corning Glass Works.

B.P. 603,077. Application date: 8.3.44. Convention date (U.S.A.): 27.1.43, 17.5.43. Accepted: 9.6.48.

Improvements in or relating to the Manufacture of Synthetic Resinous Tubing. C. E. Slaughter.

Manufacture of thermoplastic tubing by extruding a thermoplastic material to obtain a non-self-sustaining tubing, introducing a fluid within the tubing to prevent collapsing, cooling of the tubing to a temperature at which it becomes self-sustaining, and maintaining pressure within the tubing for a sufficiently long time (or for a sufficient distance from the extrusion die) to ensure that the tubing becomes self-sustaining.

B.P. 603,099. Application date: 14.6.45. Convention date (U.S.A.): 23.5.44. Accepted: 9.6.48.

Preparation of Vinyl Chloride. A. J. Johnson and A. J. Cherniavsky. To: Shell Development Co.

Production of vinyl chloride by cracking saturated hydrocarbons at temperatures of between 1,200-1,600 degrees C., separating the fraction containing ethylene and acetylene and treating this fraction with hydrogen chloride in or without the presence of a catalyst. Selective catalysts can be used, thus acetylene may be selectively hydrochlorinated to vinyl chloride and then separated from the ethylene, which, in turn, can be reacted with chlorine to ethylene dichloride. After pyrolysis this yields vinyl chloride. The hydrogen chloride is recycled.

B.P. 603,109. Application date: 10.9.45. Convention date (U.S.A.): 29.9.44. Accepted: 9.6.48.

Improvements in and relating to Bonded Flexible Non-woven Fibrous Sheeting suitable for Use in Adhesive Tapes. L. W. Eger and E. W. Engel. To: Johnson and Johnson (Gt. Britain), Ltd.

B.P. 603,130. Application date: 5.12.45. Accepted: 9.6.48.

Improvements in or relating to Preheating Ovens for the Moulding of Thermosetting and like Plastic Materials. A. P. Summerfield.

B.P. 603,154. Application date: 9.1.45. Convention date (Switzerland): 10.1.44. Accepted: 10.6.48.

Process for Improving the Fastness to Light of Dyeings or Prints produced with Vat Dyestuffs or Leuco Ester Salts thereof on Fibres, Fabrics, Films and like-shaped Structures Composed of Superpolyamides or Superpoly-Urethanes.

B.P. 603,223. Application date: 11.8.44. Accepted 11.6.48.

An Improved Manufacture of Oil Soluble Resinous Products. To: Standard Oil Development Co.

Preparation of an additive to lubricating oil by heating a phenol having an alkyl side chain with at least five carbon atoms, an aldehyde (formaldehyde, trioxymethylene) and ammonia or an amine in a mineral oil, continuing the heating process until all nitrogen is eliminated.

B.P. 603,269. Application date: 28.11.45. Convention date (U.S.A.): 7.12.44. Accepted: 11.6.48.

High-frequency Bonding Apparatus. To: The Singer Manufacturing Co.

High-frequency roller welder with special sensing device for thickness of thermoplastic material to be welded, operating and controlling output power of H.F. supply generator.

B.P. 603,323. Application date: 24.10.45. Convention date (U.S.A.): 7.12.44. Accepted: 14.6.48.

Improvements in Method of Making Battery Separators. To: United States Rubber Co.

B.P. 603,324. Application date: 24.10.45. Convention date (U.S.A.): 30.12.44. Accepted: 14.6.48.

Improvement in Oil Phase Polymerization. To: United States Rubber Co.

B.P. 603,325. Application date: 24.10.45. Convention date (U.S.A.): 30.12.44. Accepted: 14.6.48.

Improvement in Oil Phase Polymerization. To: United States Rubber Co.

B.P. 603,412. Application date: 20.10.45. Convention date (U.S.A.): 5.3.45. Accepted: 15.6.48.

A New or Improved Machine for Bonding Materials by Means of High Frequency Electric Currents. To: The Singer Manufacturing Co.

Reciprocating bar type welding machine for thermo-plastic sheets.

B.P. 603,454. Application date: 7.8.45. Accepted: 16.6.48.

Improvements relating to High Frequency Electrical Heating Apparatus. E. Mittelmann.

B.P. 603,481. Application date: 31.1.46. Convention date (U.S.A.): 31.1.45. Accepted: 16.6.48.
Modified Interpolymers. To: E. I. Du Pont de Nemours and Co.

B.P. 603,482. Application date: 31.1.46. Convention date (U.S.A.): 31.1.45. Accepted: 16.6.48.
Modified Interpolymers. To: E. I. Du Pont de Nemours and Co.

B.P. 603,525. Application date: 23.10.45. Accepted: 17.6.48.
Improvements in or relating to Straps. S. Heimann.
Plastic straps for wrist watches, belts and the like.

B.P. 603,562. Application date: 25.10.45. Convention date (U.S.A.): 2.11.44. Accepted: 17.6.48.
Improvements in or relating to the Manufacture of Laminated Products. To: Bakelite, Ltd.
Laminated structure produced from plies of fibrous material which are treated before or after assembly with a bonding agent comprising a mixture of a normally liquid vinyl monomer and a compatible polyester; heat and pressure is applied to effect proper bonding.

B.P. 603,631. Application date: 28.12.45. Convention date (U.S.A.): 18.12.44. Accepted: 18.6.48.
An Improved Method of Bonding Rubber and Synthetic Rubber to Metal. J. R. Rafter. To: The Firestone Tyre and Rubber Co.
Bonding of Rubber to magnesium or magnesium alloys by treating the surface of the metal with fluosilicic acid (or hydrofluoric acid in the presence of glass), applying a rubber metal adhesive composition to the surface so treated and pressing a rubber composition against the metal.

B.P. 603,699. Application date: 29.10.45. Convention date (U.S.A.): 27.10.44. Accepted: 21.6.48.
Improvements in or relating to the Production of Vinyl Cyanide. To: Imperial Chemical Industries, Ltd.

B.P. 603,700. Application date: 29.10.45. Convention date (U.S.A.): 27.10.44. Accepted: 21.6.48.
Improvements in or relating to the Production of Vinyl Cyanide. To: Imperial Chemical Industries, Ltd.

B.P. 603,817. Application dates: 30.10.45, 29.1.46. Accepted: 23.6.48.
Improvements in or relating to Plasticized Synthetic Resin Compositions. D. Faulkner, H. M. Stanley and J. J. P. Staudinger. To: The Distillers Co., Ltd.

B.P. 603,827. Application date: 5.11.45. (Patent of Addition to B.P. 578,079.) Accepted: 23.6.48.
Improvements relating to the Manufacture of Artificial Fibres from Highly Polymeric Substances. J. R. Whinfield and J. T. Dickson.
Refers to polymethylene terephthalate fibres.

B.P. 603,835. Application date: 17.12.45. Convention date (France): 19.1.45. Accepted: 23.6.48.
Improvements in Processes for Manufacturing Synthetic Resin. To: Société Générale des Huiles de Pétrole.
Preparation of Synthetic resins from "red oil" by condensing with a phenol and an aldehyde in the presence of a catalyst.

B.P. 603,838. Application date: 22.3.45. Accepted: 23.6.48.
Improvements in the Production of Yarns, Threads, Cords and Ropes. A. H. Little. To: Imperial Chemical Industries, Ltd.
Relates to polyethylene terephthalate fibres, yarns, etc.

B.P. 603,840. Application date: 22.5.46. Accepted: 23.6.48.
Improvements in or relating to Artificial Filaments, Films and similar Articles. L. Leben and A. H. Little. To: Imperial Chemical Industries, Ltd.
Refers to polyethylene terephthalates.

B.P. 603,842. Application date: 28.3.46. Accepted: 23.6.48.
Improvements in the Production of Drawn Filaments, Yarns, Bristles, Ribbons, Film and like Structures from Aromatic Polyesters. R. J. W. Reynold and L. Wood. To: Imperial Chemical Industries Ltd.

B.P. 603,843. Application date: 28.3.46. Accepted: 23.6.48.
Drawing of Aromatic Polyester Filaments, Yarns, Ribbons and like Structures. D. McCreath and L. Wood. To: Imperial Chemical Industries, Ltd.

B.P. 603,855. Application date: 1.11.45. Convention date (U.S.A.): 1.11.44. Accepted: 24.6.48.
Improvements in or relating to the Production of Fluoro-hydrocarbons. To: Imperial Chemical Industries, Ltd.
Refers to the production of vinyl fluorides.

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(*Continued from page 567*)

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A small exhibition of representative plastic mouldings made by British Moulded Plastics, Ltd., and Moulded Products, Ltd., was held at the Grand Central Hotel, Belfast, October 18 to 22, when Belfast industrialists showed great interest. The products of the companies concerned are handled in Northern Ireland by Caledonian Plastics, Ltd.

A DISPLAY OF PACKAGING MATERIAL for varied purposes, arranged by British Celanese, Ltd., at Celanese House, Hanover Square, London, W.1, will be open to trade buyers from November 15 for a period of three weeks, Mondays to Fridays, 10 a.m. to 4 p.m.

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Leaves from a Moulder's Notebook

This is the twenty-third in a series of notes by the B.I.P. Development Department on the problems of the moulder and designer. Nos. 1—12 in this series are now available in booklet form and B.I.P. will be pleased to send a copy of this and subsequent notes on request. Comments and enquiries are welcome.

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The main problem in pelleting is to compress the material uniformly to an extent which will ensure (*a*) adequate strength in transit from one department to another and (*b*) uniformity of weight of pellets.

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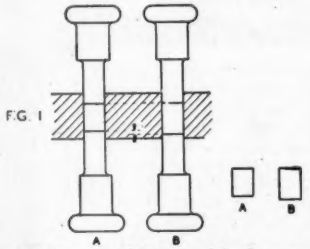

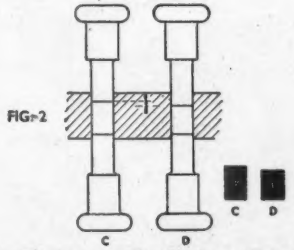

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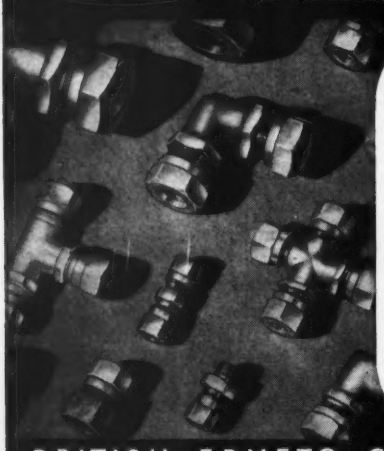

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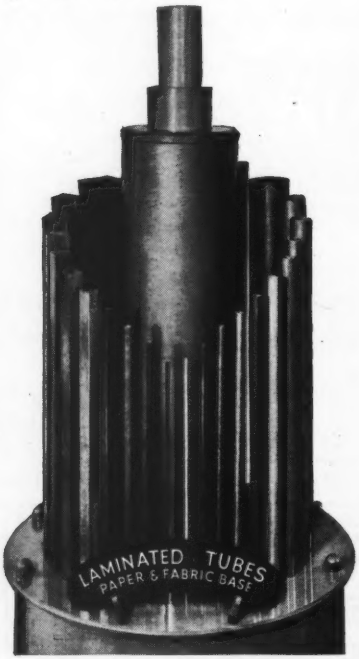

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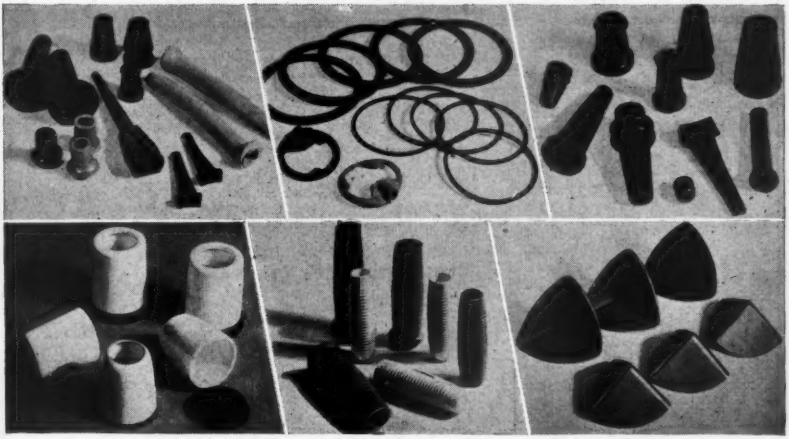

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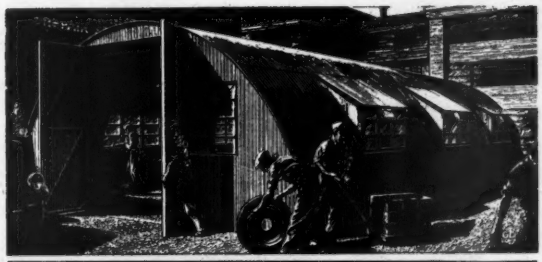

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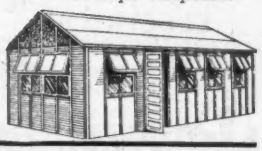

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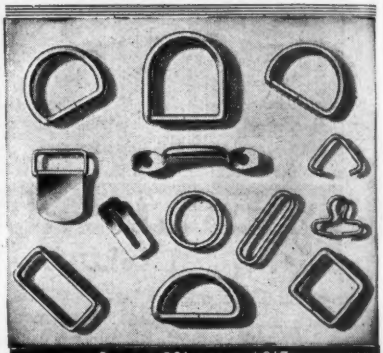

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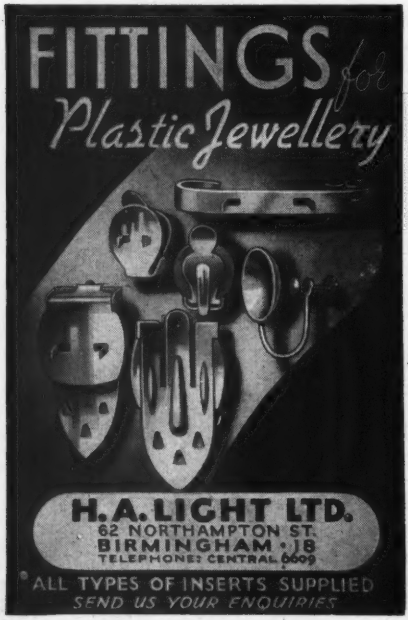

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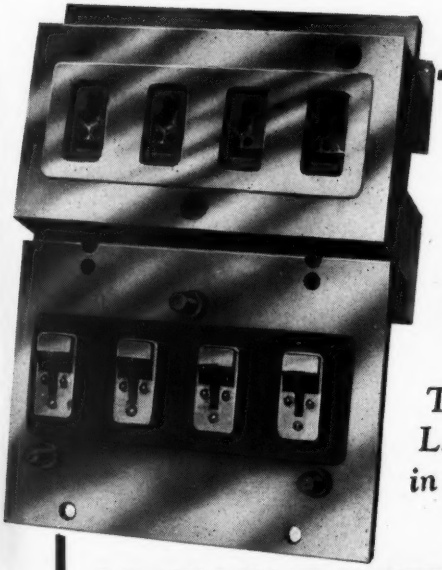

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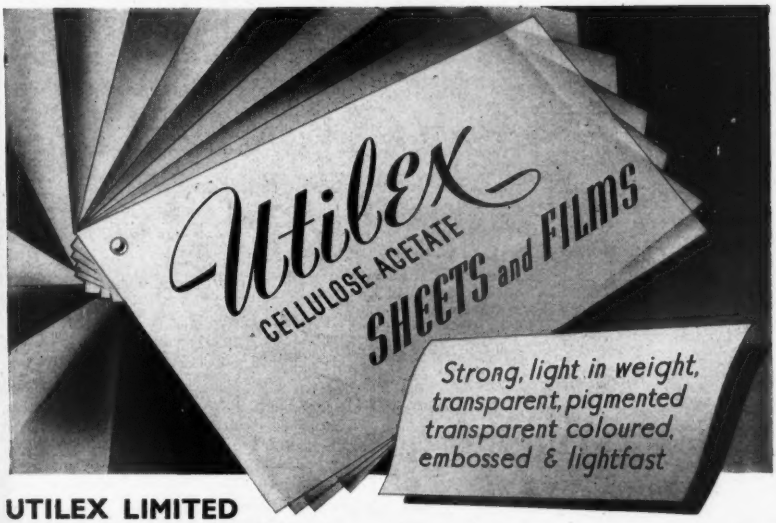

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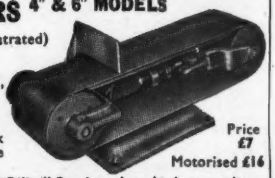

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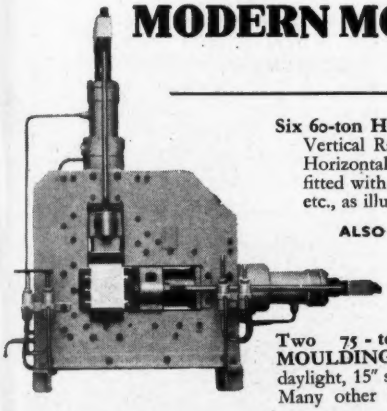

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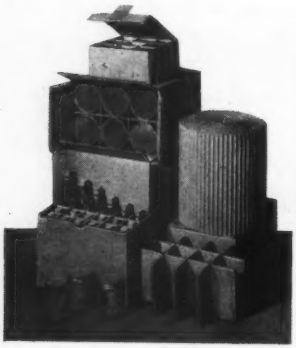

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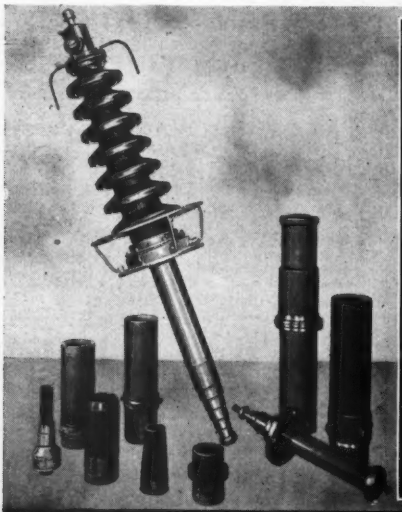

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To clear. Cellulose acetate sheets, rods and moulding powder, P.V.C. sheeting, Bakelite moulding powder black and natural. Ask for details. Box 6545, care of "Plastics." 138-10

Clear Perspex required, any thickness, sheets or off-cuts; possibly paper-covered flat material. Offers to: Rodjn, 37 Lord Avenue, Ilford, Essex. 138-18

Cellulose Acetate.
4 mm. Green, 55 ins. by 24 ins., 20 sheets.
4 mm. Red, 55 ins. by 24 ins., 28 sheets.
.080 Black, 55 ins. by 24 ins., 48 sheets.
.060 Black, 56 ins. by 25 ins., 27 sheets.
.080 Black, 36 ins. by 20 ins., 22 sheets.
.010 Clear, 49 ins. by 21 ins., 6 sheets.
.120 Clear, 49 ins. by 21 ins., 7 sheets.
Available immediate delivery at reduced prices. Write, Box 6553, care of "Plastics." 138-20

Buna-plast, a blending of synthetic rubber and P.V.C. specially processed for manufacturing leather substitute; this material is far superior to plasticized P.V.C.. inquiries welcomed. Dohm, Ltd., 167 Victoria Street, London, S.W.1. zzz-230

Raw Material Available and Wanted (contd.)

Catalin ¼-in. rose quartoz 18 ins. by 12 ins., 28 sheets available reduced price. Box 6552, care of "Plastics." 138-19

P.V.C. calendering compound in a range of opaque colours. Dohm, Ltd., 167 Victoria Street, London, S.W.1. zzz-229

Always large stocks of
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rods, tubes and sheets,
PERSPEX
sheets up to 1-in. thick.
CELLULOSE ACETATE.
S. Rosenfeld,
93 Aldersgate Street, E.C.1.
Phone, Monarch 4686. 138-0250

Polystyrene moulding scrap urgently required, state amount available and send small sample. Box 3185, care of "Plastics." zzz-228

1st quality virgin cellulose acetate moulding powder available. Box 3184, care of "Plastics." zzz-227

Polythene moulding powder (reconstituted) in black natural and a variety of colours. Dohm, Ltd., 167 Victoria Street, London S.W.1. zzz-226

Metal powders and oxides. Quotations and samples on application. Dohm, Ltd., 167 Victoria Street, London, S.W.1. zzz-225

Perspex acrylic sheet.
Large range of colours from 1-16 in. to ½ in. Large stocks, good delivery.
J. H. Berry (Plastics), Annesley Woodhouse, Notts. Phone, East Kirkby 2151. 140-569

About 7 cwts. of P.V.C. thread, blue, brown and black on wood reels. John Walton and Co. (Castleside), Ltd., Metalex Works, Gt. Cambridge Road, Enfield, Middx. 139-500

I.C.I. Perspex dyes and solvents for disposal at less than cost. Box 6251, care of "Plastics." 139-498

Perspex tubing. We can now supply welded Perspex tubing from ¼ bore upwards. Inquiries invited. Evolite Plastics, Ltd., 325 Latimer Road, W.10. Phone, Lad 1879. 138-4011

Reclaimed X-ray Sheet, blue tinted. Sizes 6 ins. by 4 ins., 8½ ins. by 6½ ins., 10 ins. by 8 ins., at 1s. 9d. per lb. in 1-ton lots; size 12 ins. by 10 ins., at 2s. per lb. in 1-ton lots; size 15 ins. by 12 ins., at 2s. 6d. per lb., in 1-ton lots; size 17 ins. by 14 ins., at 3s. per lb., in 1-ton lots. Intermediate sizes also available. Delivery from stock.
Reclaimed nitrate X-ray sheet, various sizes, at 1s. 3d. per lb., in 1-ton lots; 5 tons available.
Scrap Perspex, clear, transparent, various sizes, thicknesses and shapes, 1s. per lb., in 1-ton lots; 5 tons available.
Plastic scrap, very mixed assortment, colours and shapes, 6d. per lb., in 1-ton lots; 5 tons available.
Acetate flakes, clear, transparent, 9d. per lb., in 1-ton lots.
Clear transparent acetate sheet film, 10 ins. by 6 ins., 10-thou. thick, brand-new material, 3s. 6d. per lb., in 1-ton lots.
Lloyds, 4-5 Church Street, Christchurch. Phone, Christchurch 504. zzz-241

Accurate Powders for all industries. Dohm, Ltd., 167 Victoria Street, London, S.W.1. 140-536

Raw Material Available and Wanted (contd.)

Cresylic acid, few tons available, grades A and B, surplus to requirements. Box 6554, care of "Plastics." 140-540

Approximately 1 ton of each. Polythene and P.V.C. cable strippings. Offers for the lot. Can be seen Liverpool any time. Must clear. Write L. Mosley, 137a Kensington, Liverpool. 138-x7827

D. H. Ridout and Son, Ltd., Reg. Office. 12 Stedman Road, Southbourne, Bournemouth. Phone, Southbourne 505.
Official stockists for I.C.I. acrylic Perspex, crystal and coloured, and "Crinothene" sheeting in all shades.
Offer acetate and celluloid transparent sheeting from 2s. per lb.
Bakelite laminated sheeting from 1s. 10d. per lb.
Coloured and clear Perspex off-cuts at 1s. 3d. to 2s. per lb. according to gauge and quantity required.
All types of plastic tubes and rod from 4d. per foot.
1¼-in. ribbed plastic belting at 6d. per yard.
Perspex No. 6 and No. 2 quick-drying cements and polishes.
Special offer of 1-oz. and ½-oz. amber bottles with plastic screw stoppers at 15s. per gross.
Send for new stock list which contains numerous interesting items to opticians and manufacturers of finished plastic goods.
Surplus stocks purchased.
D. H. Ridout and Son Ltd., Stedman Road, Southbourne, Bournemouth. 138-24

Scrap. Why not let a well-established firm quote you for cellulose acetate, polystyrene and other thermoplastic off-cuts and scrap? Having best use for these materials, highest prices can be paid. Quotations on receipt of representative samples to M. H. Grist (Plastics), Ltd., 82-84 Brighton Road, Surbiton, Surrey. Phone, Elmbridge 4214. 138-25

Wanted, clear transparent cellulose acetate and Perspex scrap. Below.
For sale clear transparent acetate sheets, 1½, 2, 2¼ and 3 mm thickness, reply Box 6570, care of "Plastics." 138-26

SITUATIONS VACANT

None of the vacancies in these columns relates to a man between the ages of 18 and 50, inclusive, or a woman between the ages of 18 and 40, inclusive, unless he or she is excepted from the provisions of the Control of Engagement Order, 1947, or the vacancy is for employment excepted from the provisions of that Order.

Draughtsman (senior), jig and tool, for interesting post with electrical and mechanical engineers, S.W. London area, must have served recognized apprenticeship and be conversant with press tools, plastic moulds, hydraulics and general tooling. Higher National education essential, some electrical knowledge preferred. Salary up to £450 per annum, according to age and experience. Write full particulars to Box 5848, care of "Plastics." 138-433

Chemist with Honours Degree or equivalent is required for newly established development department of firm in North of England; experience in the coating of cloth with rubber or plastics is desirable but not necessary; a salary fully in accord with age and experience is available for the right man. Apply by letter giving particulars of age and qualifications to Box 6249, care of "Plastics." All responsible employees of the advertiser have been informed of this advertisement. 138-497

Situations Vacant (contd.)

AN AUSTRALIAN PLASTICS COMPANY has vacancies for a number of thoroughly experienced personnel in positions offering very good prospects for men desirous of immigrating to Australia.

Vacancies exist for:—TOOL-ROOM: Manager, Foreman and Sub-Foreman. INJECTION MOULDING: Manager and Foreman. PLATING, HARD CHROME: A very capable Foreman. HAIR-BRUSH MANUFACTURE: Foreman and Sub-Foreman.

A Representative of the Company will visit England early November to interview applicants. Interviews will be invited only from those written applications which give the fullest possible details, both personal and in relation to experience.

The Company will materially assist in the immigration arrangements of selected applicants. Salaries will be discussed at the interview.

Apply to:—A.P.I., COMMERCIAL BANK OF AUSTRALIA, LTD., 12 OLD JEWRY, LONDON, E.C.2. 138-501

Required for established works with modern equipment in North England, a senior technician with up-to-date practical experience of calendering, extruding and spreading of P.V.C. Applicant must be prepared to take complete responsiblity for these departments. Remuneration appropriate to a first-class man. Assistance with housing. Write giving details of age, experience, present position and salary to Box 6539, care of "Plastics." 138-16

Calender man wanted with an all-round experience on P.V.C. sheeting and fabric coating. House available to a suitable applicant and the rate of pay will be 3s. per hour with opportunity of overtime. Apply giving full details of experience, age, etc., to Box 6537, care of "Plastics." 140-531

Extruder wanted for the West, with all-round experience on varied sections for the motor car trade. Good pay and conditions with excellent prospects of promotion for the right man. Apply stating age, experience, etc., to Box 6538, care of "Plastics. 140-532

Chemist or Physicist with Honours Degree required by progressive company, London area, engaged in rubber and plastics materials manufacture. Applicants should have had at least five years experience in plastics industry. Knowledge of rubber an advantage, but not essential. Good references required. Applicants must be of British nationality and strict disciplinarians, able to take responsibility for research and development work. Not over 40 years of age. Salary according to age and experience. Full particulars to Box 6542, care of "Plastics." 139-535

Travellers required to obtain plastic moulding work and welded plastic goods in P.V.C. and acetate. Very good commission offered. Box 6551, care of "Plastics." 139-539

Thermo-plastic Extrusions. The services are required of a man skilled in the shop processing and production of the foregoing. Applicants should file a complete statement of their industrial experience with present and past situations held Excellent scope for successful candidate and top salary will be paid. Box 680, Dorland Advertising, 18-20 Regent Street, S.W.1. 138-22

Works Foreman for medium-sized injection moulding plant required, must be fully experienced, qualified toolmaker preferred, only first-class men need apply. Particulars, Box 6569, care of "Plastics." 138-23

SITUATIONS WANTED

New products designer seeks change (South), unpublished inventions ready. Box 6548, care of "Plastics." 138-5

TIME RECORDERS

Factory time recorders. Service rental. Phone, Hop 2239. Time Recorder Supply and Maintenance Co., 157-159 Borough High Street, S.E.1. 149-544

MISCELLANEOUS

Engraved name plates, scales, dials, etc., supplied. Tickets and Co., Box 2, Silver Street, Leicester. 141-5699

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Packing cases and boxes for all purposes. F. Rawle and Co., Ltd., 71 Kensington Avenue, London, E.12. Phone, Grangewood 2003. 147-441

Huts, Nissen type, reconditioned, 24-ft. span and 16-ft. span, any length. These huts are repaired, painted and completely reconditioned. Prompt despatch. Also other industrial buildings suitable for workshops, stores, garages, canteens, offices, etc. Write, phone or call for details: J. Thorn and Sons, Ltd., Box 138, Brampton Road, Bexleyheath, Kent. Phone, Bexleyheath 305. zzz-239

50,000 map cases, from which can be cut two celluloid sheets 1 ft. 4 ins. by 1 ft. Carbot, Ltd., 201-205 Long Lane, London S.E.1. Phone, Hop 1762. 138-x5335

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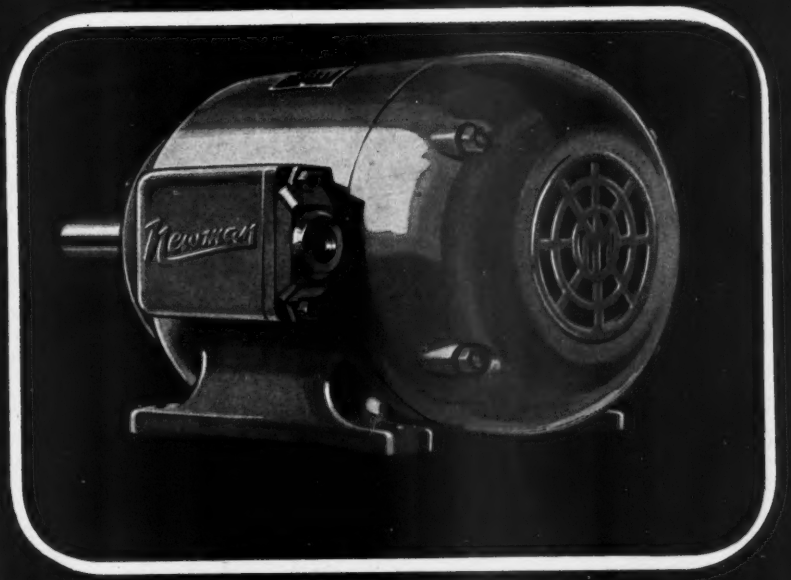

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